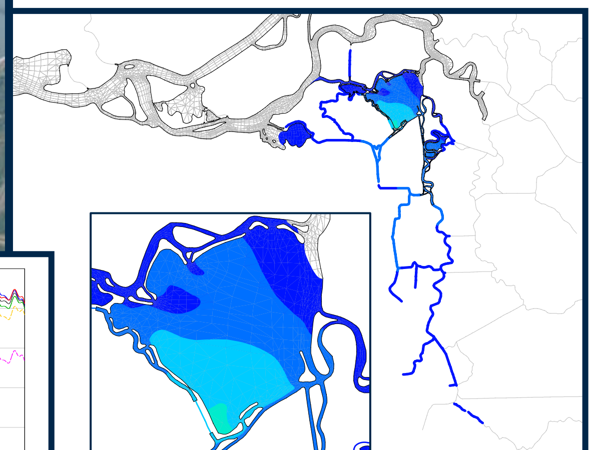
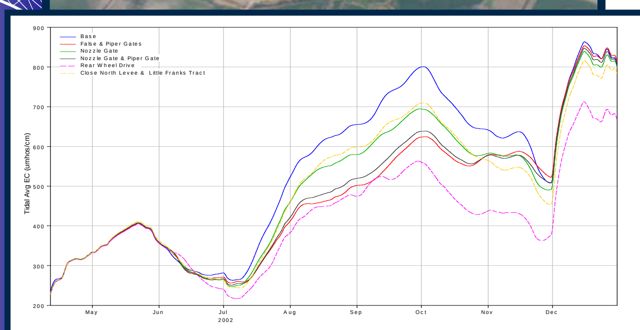
FLOODED ISLANDS
PRE-FEASIBILITY STUDY

ALTERNATIVES MODELING REPORT





Prepared For:

California Department of Water Resources

For Submittal To:

California Bay-Delta Authority

June 30, 2005

Prepared By:

RMA Resource Management Associates

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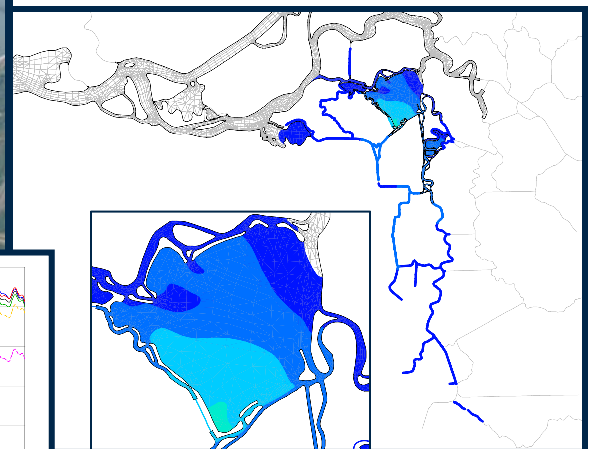

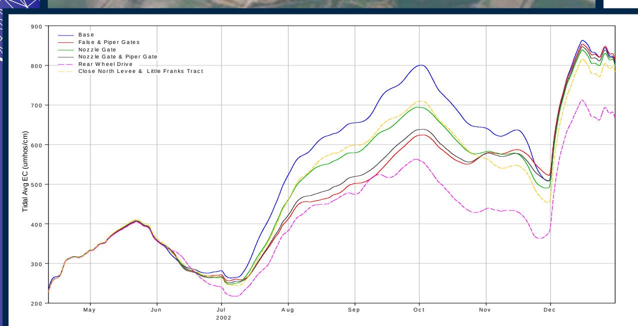

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1 INTRODUCTION

The calibrated RMA finite element model of Sacramento – San Joaquin Delta is used to evaluate ten alternatives for management of Franks Tract to improve water quality in the Delta. This document serves to describe the alternatives and report their impacts on EC, stage, and velocity (scour) in the Delta, and residence time in Franks Tract.

Calibration of the RMA Delta model is described in *Flooded Islands Pre-Feasibility Study, RMA Delta Model Calibration* (June 2005).

1.1 BACKGROUND

The purpose of the Flooded Islands Study is to evaluate potential to create water quality, ecosystem, recreation and other benefits at Franks Tract, Lower Sherman Lake and Big Break. Of these three study areas, the most intensively investigated has been Franks Tract because preliminary field and model data indicate that hydrodynamic conditions of the island may result in dramatic effects in overall salinity conditions in the Delta.

Franks Tract is located in the central Delta and is bound by False River and Webb Tract to the north, Old River and Mandeville Island to the east, Sand Mound Slough and Holland Tract to the southeast, and Piper Slough and Bethel Tract to the southwest. Franks Tract is approximately 3,300 ac. Little Franks Tract, a smaller submerged area of 330 ac, lies to the west and is separated from Franks Tract by levees. A color contour plot of bathymetry in the Franks Tract vicinity is shown in Figure 1-1.

Franks Tract is connected tidally to the San Joaquin River via False River. During low flow conditions, high salinity water enters Franks Tract on flood tide while fresher water flows back into False River during ebb tide. The higher salinity water mixes within Franks Tract and is drawn into Old River through levee breaches on the east side of Franks Tract. This impacts salinity conditions in the adjacent Delta channels and the central and south Delta overall.

Examination of a variety of Franks Tract management alternatives has been undertaken to develop a better understanding of the complex physical phenomena involved with the salinity intrusion and mixing occurring within Franks Tract. With this knowledge, preferred alternatives for Delta water quality improvement can be selected and optimized.

1.2 OBJECTIVES

The objective of this effort was to analyze a variety of Franks Tract management alternatives that might improve water quality in the Delta while minimizing adverse impacts such as increased residence time in Franks Tract, increased scour in sensitive locations, decreased stage in the Delta, or increased flooding risk. The following management alternatives considered incorporate combinations of levee repairs, operable gates and barriers:

- No Franks Tract;
- East Side Open;
- Cox Alternative;
- West False River Gate;
- West False River Gate 1/3 Open;
- False River and Piper Slough Gates;
- North Levee and Nozzle Gate;
- North Levee, Nozzle Gate and Piper Slough Gate;
- East Levee and Gates; and
- North Levee and Close Little Franks Tract.

Measurable salinity impacts at the primary export locations and throughout the Delta result from small changes in flow and mixing processes at the tidal time scale integrated over weeks and months. Understanding and accurately representing the changes in short time scale flow and mixing processes in the model is critical to predicting the impacts of proposed alternatives. April through December 2002 was selected as the analysis period for the Pre-Feasibility alternative simulations. This period corresponds with the most recent detailed calibration period for the RMA Delta Model and the extensive field monitoring program by the USGS in the Franks Tract Region. 2002 was considered a dry year, although the period encompasses a significant range of inflows, exports, and tidal conditions.

The emphasis of the Pre-Feasibility phase of the Flooded Islands Study is on relative ranking of a wide range of proposed alternatives. Focusing model simulations on a single water year type is appropriate for screening the alternatives. As the project moves toward recommendation of a single preferred alternative, absolute prediction of water quality impacts over a range of water year types becomes more important in evaluating the benefits of the project. At that time, additional simulations will be conducted representing a wider range of year types.

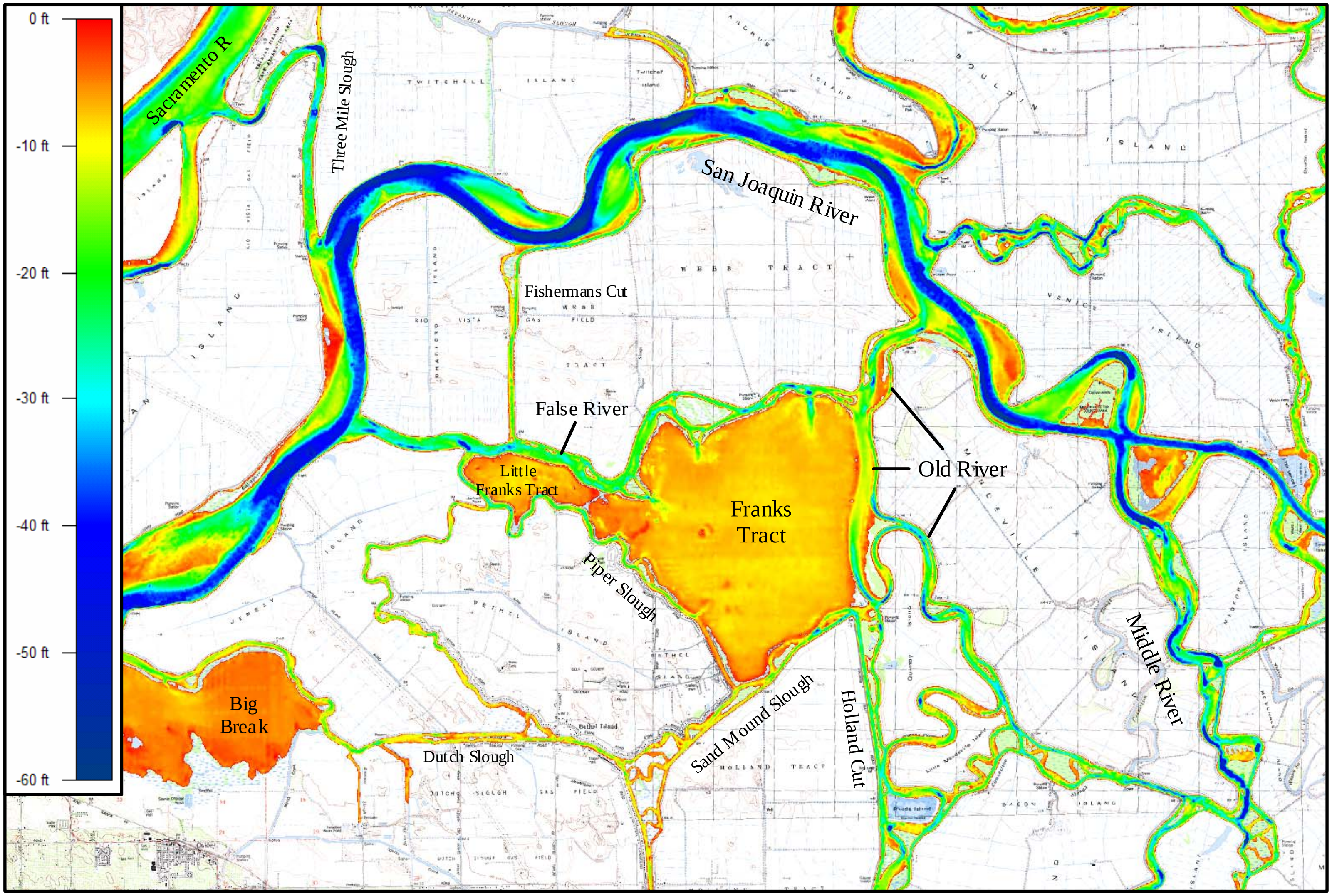

Figure 1-1 Color contours of bathymetry (ft NGVD) in the Franks Tract vicinity.

2 ALTERNATIVE DESCRIPTIONS

A Base case and ten alternative scenarios were simulated to examine the impacts of modifications around Franks Tract on EC, stage and velocity throughout the Delta and residence time in Franks Tract. The alternatives implement various degrees of levee reconstruction, in-channel barriers, and/or operable gates with the primary objective of reducing salinity in the central and southern Delta.

Several of the alternatives employ gated structures situated to the west of Franks Tract on False River and/or on Piper Slough. Other alternatives entail different levels of levee reconstruction along the north and west sides of Franks Tract. These two sets of alternatives aim to reduce salinity mixing in the central Delta by keeping the higher salinity water from entering Franks Tract from the west. The gates on the gated alternatives are open on ebb tide to maintain circulation in Franks Tract. Future analysis may examine optimizing gate operation for salinity reduction while maintaining low residence time in Franks Tract.

Two of the alternatives employ barriers/gates and or restored levees on the east side of Franks Tract. For these alternatives, salinity in Franks Tract is allowed to increase in the summer and fall, rather salinity reduction in the south Delta is obtained by isolating Franks Tract from Old River.

2.1 BASE CASE

This simulation was performed using the calibrated model with currently existing conditions. The full model configuration for the Base case is shown in Figure 2-1.

2.2 NO FRANKS TRACT

This alternative is intended at a “bookend” only to help bracket the impacts of Franks Tract on the system, and it is not considered a possibility for implementation. All levees around Franks Tract are closed so that there is no exchange between Franks Tract and the surrounding channels. For modeling purposes, Franks Tract is removed from the finite element mesh.

2.3 EAST SIDE OPEN

For this alternative, shown in Figure 2-2, all Franks Tract levees along False River and Piper Slough are closed, while the east side levees along Old River and Sand Mound Slough are left open. The north levee on Little Franks Tract is also closed.

With the north and southeast sides of Franks Tract closed, False River remains the major conduit of higher salinity water into the Delta.

2.4 COX ALTERNATIVE

For the Cox Alternative, no levee work is done. Barriers are placed in Old River and Holland Cut at Quimby Island as shown in Figure 2-3. Barriers remain in place from June through the end of the simulation, although it is assumed that in reality the barriers would be removed in the winter, if this alternative was implemented.

2.5 WEST FALSE RIVER GATE

For the False River Gate alternative, an operable gate is placed in False River between the San Joaquin River and Piper Slough as shown in Figure 2-4. The gate is closed on the flood tide and open on ebb tide. No levee work is done. The gate is operated from June through the end of the simulation, although it is assumed that in reality the gate would be kept open during the winter, if this alternative was implemented.

2.6 WEST FALSE RIVER GATE 1/3 OPEN

This alternative is the same as the alternative above, except that on the ebb tide, only 1/3 of the flow is allowed through the gate. The gate is closed on the flood tide. The gate is operated from June through the end of the simulation, although it is assumed that in reality the gate would be kept open during the winter, if this alternative was implemented.

2.7 FALSE RIVER AND PIPER SLOUGH GATES

For this alternative, operable gates are placed in False River between Franks Tract and Little Franks Tract, and in Piper Slough near the east end of Little Franks Tract (see Figure 2-5). The gates are open on the ebb tide and closed on the flood tide. No levee work is done. The gates are operated from June through the end of the simulation, although it is assumed that in reality the gates would be kept open during the winter, if this alternative was implemented.

2.8 NORTH LEVEE AND NOZZLE GATE

For the North Levee and Nozzle Gate alternative, shown in Figure 2-6, an operable gate is constructed at the nozzle in Franks Tract. The gate is open on the ebb tide and closed on the flood tide. All remaining levees along False River, including on Little Franks Tract, are repaired. The gate is operated from June through the end of the simulation, although it is assumed that in reality the gate would be kept open during the winter, if this alternative was implemented.

2.9 NORTH LEVEE, NOZZLE GATE AND PIPER SLOUGH GATE

This alternative is the same as the North Levee and Nozzle Gate alternative above, with the addition of an operable gate in Piper Slough near the western end of Little Franks Tract (see Figure 2-7). The Piper Slough gate is open on the ebb tide and closed on the flood tide.

2.10 EAST LEVEE AND GATES

This alternative implements measures at the rear of Franks Tract and has thus been referred to as a “rear wheel drive” alternative. The east Franks Tract levees along Old River are all closed. Gates are placed at the east ends of False River and Sand Mound Slough (see Figure 2-8). The False River and Sand Mound Slough gates are closed in mid-June and remain closed through the end of the simulation in December. The Old River gate remains open throughout the year. Future phases of work will address optimization of operation of the three gates.

2.11 NORTH LEVEE AND CLOSE LITTLE FRANKS TRACT

For this alternative, the north levees on Franks Tract are closed, and all levees on Little Franks Tract are closed so that there is no exchange with surrounding channels (see Figure 2-9).

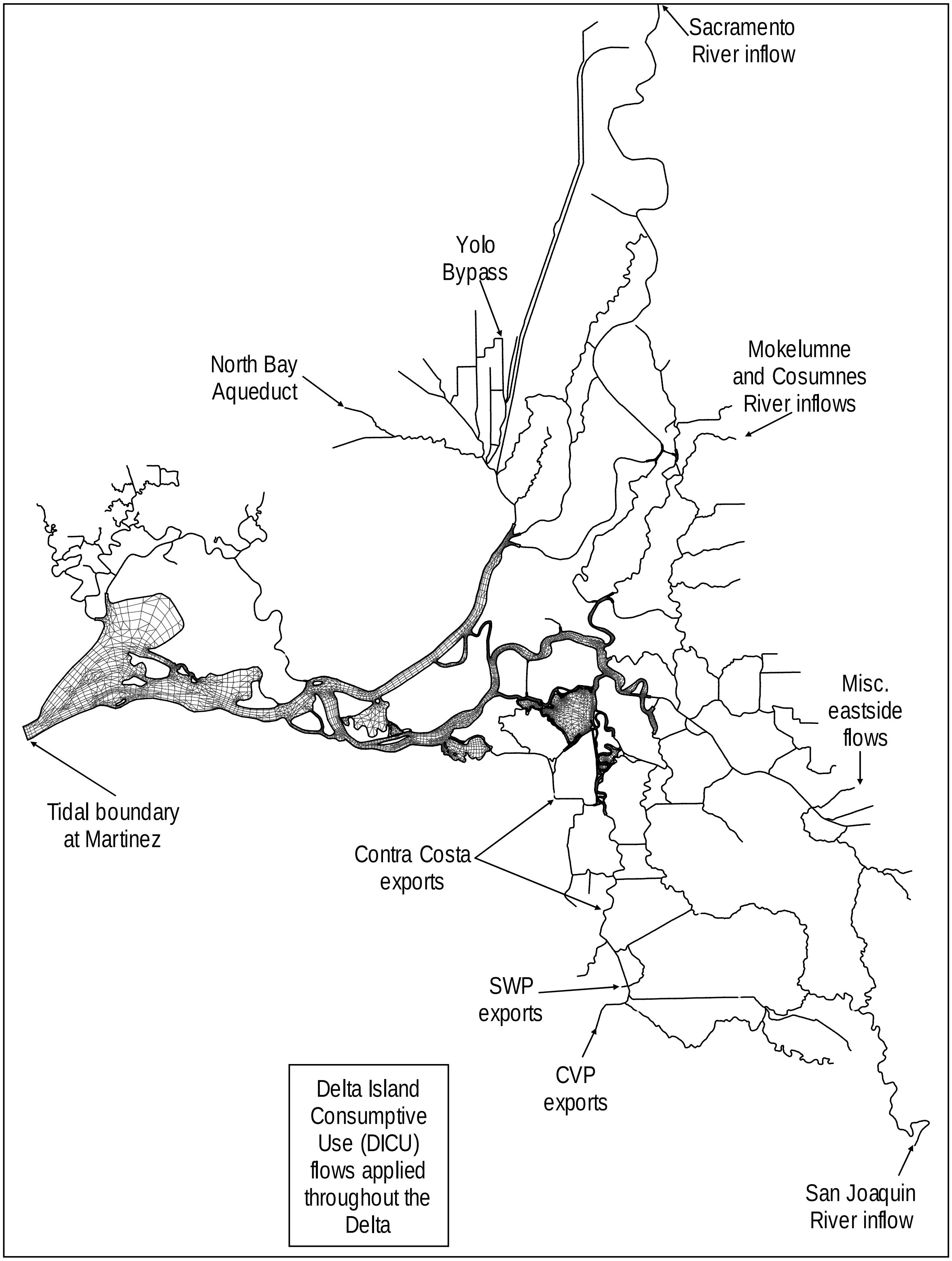

Figure 2-1 Base case model configuration.

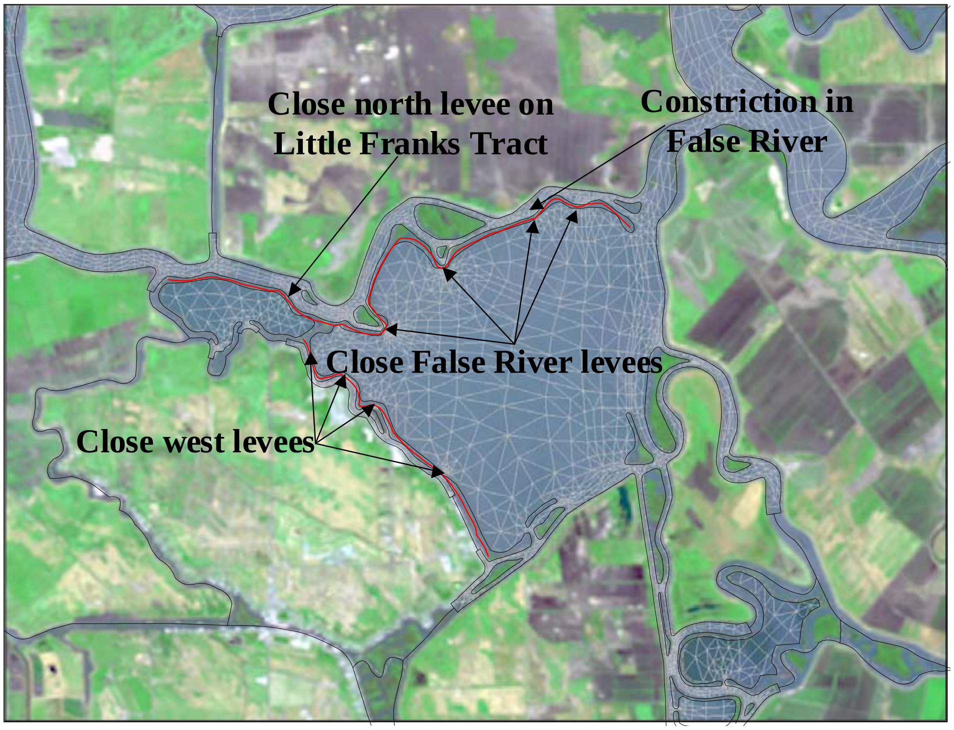

Figure 2-2 Grid for "East Side Open" alternative.

Figure 2-3 Grid for "Cox Alternative".

Figure 2-4 Grid for "West False River Gate" alternative.

Figure 2-5 Grid for "False River and Piper Slough Gates" alternative.

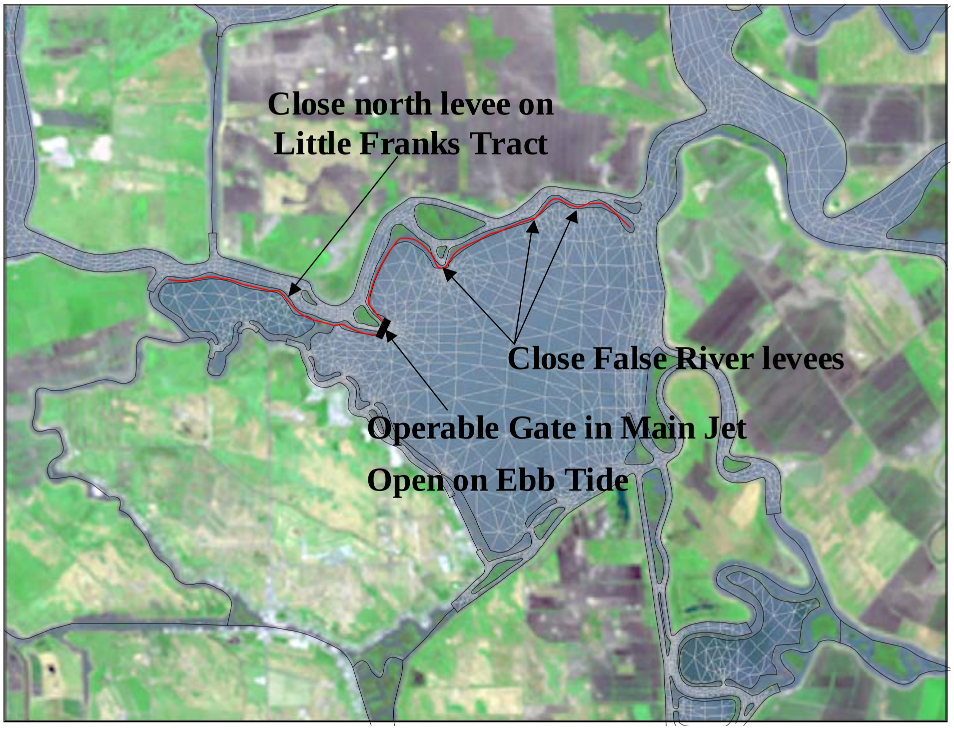

Figure 2-6 Grid for "North Levee and Nozzle Gate" alternative.

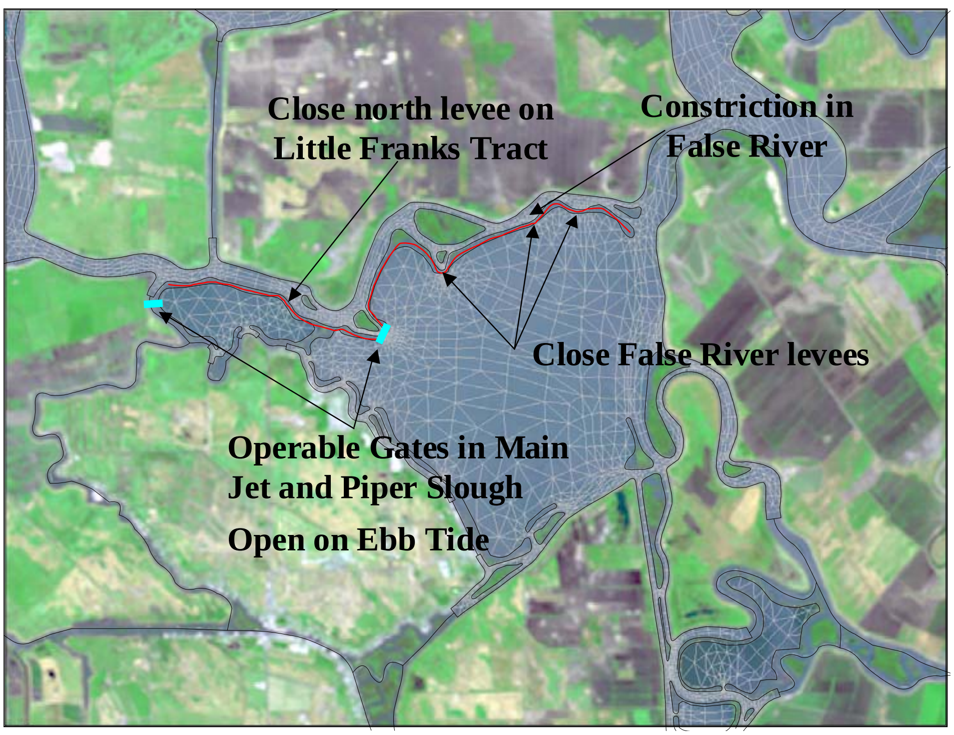

Figure 2-7 Grid for "North Levee, Nozzle Gate and Piper Slough Gate" alternative.

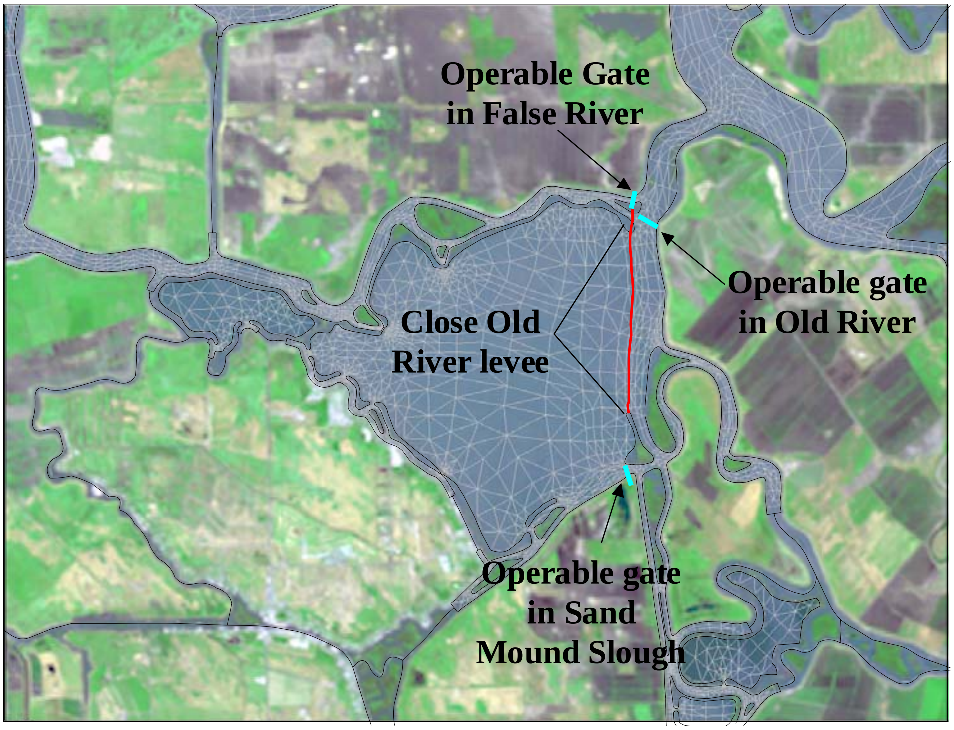

Figure 2-8 Grid for "East Levee and Gates" alternative.

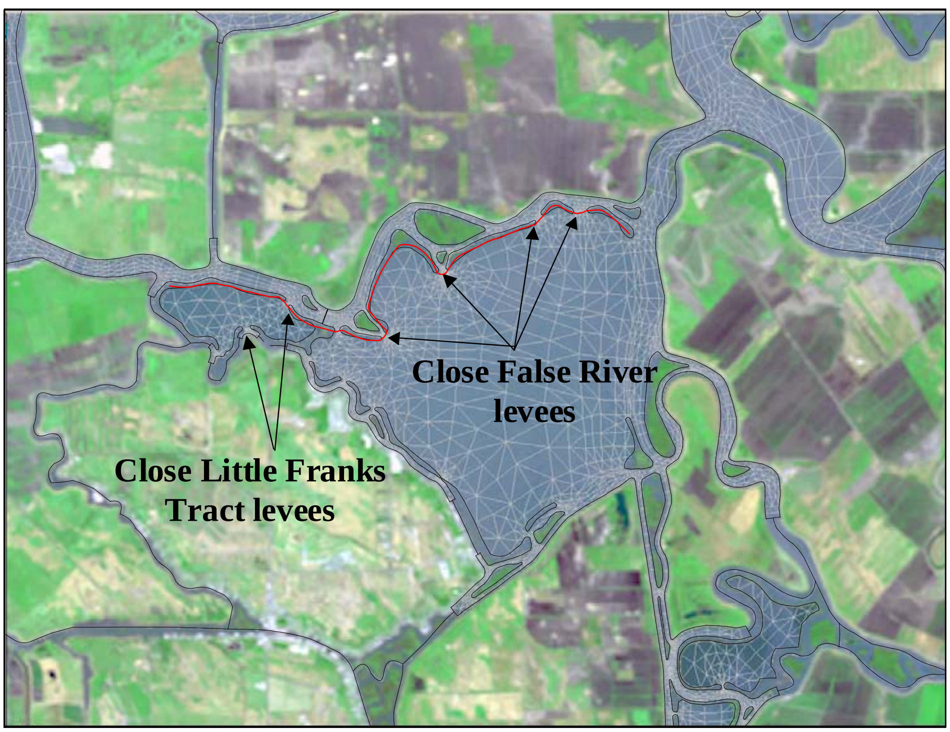

Figure 2-9 Grid for "Close North Levees and Little Franks Tract" alternative.

3 SIMULATION PERIOD

3.1 OVERVIEW

The Base case and alternative simulations were performed for the period of April 10, 2002 through January 1, 2003. This simulation period incorporates the calibration period (April 10 – October 1, 2002). Water year 2002 is classified as a dry year.

Hydrodynamic model operation requires specification of the tidal stage at Martinez and inflow and withdrawal rates at other external boundaries. Gate and barrier operations are also included in the model.

3.2 TIDAL BOUNDARY

The tidal boundary is set at Martinez using observed 15-minute stage data from IEP. The tide used for the simulation period is plotted in Figure 3-1.

USGS observed surface and bottom EC at Benicia Bridge is plotted in Figure 3-2. The average of the surface and bottom EC was used to set the Martinez boundary condition in the model. Where USGS bottom data were unavailable, CDEC bottom EC data at Martinez were averaged with the USGS surface EC.

3.3 RIVER INFLOWS

Daily average inflow boundary conditions are applied for the Sacramento River, San Joaquin River, Cosumnes River, Mokelumne River, Calaveras River, and miscellaneous eastside flows. The model interpolates between the daily average flows at noon each day.

Dayflow data (from http://www.iep.ca.gov/dayflow/index.html) are used to set boundary conditions for Sacramento, San Joaquin, Cosumnes and Mokelumne Rivers. Calaveras flows are DWR DSM2 flows from the RCAL009 station on the IEP website (http://iep.water.ca.gov/cgi-bin/dss/dss1.pl?station=RCAL009). The miscellaneous eastside flows boundary condition is set using Dayflow values for “MISC” less the Calaveras River flows.

Inflow locations are shown in Figure 2-1. Sacramento and San Joaquin River flows and NDO for the calibration period are plotted in Figure 3-3.

3.4 DELTA EXPORTS

Delta exports applied in the model include SWP, CVP, Contra Costa exports at Rock Slough and Old River intakes, and North Bay Aqueduct. Exports are plotted for the calibration period in Figure 3-4.

Daily average export flows from Dayflow (http://www.iep.ca.gov/dayflow/index.html) are used for the CVP and North Bay Aqueduct. Contra Costa's Old River export flows are from IEP at ROLD034 (http://iep.water.ca.gov/cgi-bin/dss/dss1.pl?station=ROLD034). Contra Costa's Rock Slough export flows are the difference between the Dayflow values for "CCC" and the IEP values for the Old River intake. Hourly SWP export flows are computed from hourly IEP time series data of:

1. water surface elevations outside Clifton Court Forebay;
2. water surface elevations inside Clifton Court Forebay; and
3. Gate opening height of the five Clifton Court Forebay Gates.

These data are input into the gate flow equations shown below, which were developed by Hills (1988).

$$Q_1 = H_1 \left\{ 0.44 + 215.224 \left(Elev_{outside} - Elev_{inside} \right)^{1/2} \right\}$$

$$Q_2 = H_2 \left\{ 4.46 + 181.804 \left(Elev_{outside} - Elev_{inside} \right)^{1/2} \right\}$$

$$Q_3 = H_3 \left\{ 4.76 + 173.378 \left(Elev_{outside} - Elev_{inside} \right)^{1/2} \right\}$$

$$Q_4 = H_4 \left\{ 3.38 + 173.378 \left(Elev_{outside} - Elev_{inside} \right)^{1/2} \right\}$$

$$Q_5 = H_5 \left\{ 2.38 + 168.790 \left(Elev_{outside} - Elev_{inside} \right)^{1/2} \right\}$$

$$Q_{total} = Q_1 + Q_2 + Q_3 + Q_4 + Q_5$$

Where,

$Q_i =$ flow through gate *i* (cfs),

$H_i =$ gate height/gate position of gate *i* (ft),

$Elev_{outside} =$ stage outside Clifton Court Forebay (ft),

$Elev_{inside} =$ stage inside Clifton Court Forebay (ft), and

$Q_{total} =$ total Clifton Court gates inflow (cfs).

The Clifton Court inflow equations are discussed in detail in Chapter 12 of *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh* (DWR, 2004).

3.5 DELTA ISLAND CONSUMPTIVE USE

DICU values were applied on a monthly average basis and were derived from monthly DSM2 input values. Monthly average DICU flows are plotted in Figure 3-4.

To appropriately distribute DICU flows in the model, RMA developed a utility program to match nodes in DSM2 to elements in the RMA model using UTM coordinates. This program was used to specify the RMA2 element inflows and withdrawals for each month, and salinity loadings from the agricultural returns. DICU flows incorporate channel depletions, infiltration, evaporation, and precipitation, as well as Delta island agricultural use. Table 3-1 summarizes the total monthly diversions (incorporates agricultural use, evaporation and precipitation), drains (agricultural returns), seeps (channel depletions) and total flows used for DICU flows. These flows are distributed to multiple elements throughout the Delta, as shown in Figure 3-5. Negative total flows are net withdrawals from the system. Note that the DICU for December is a net inflow to the system due to precipitation and runoff.

Table 3-1 Summary of monthly DICU flows in cfs.

Month	Diversions (-)	Drains (+)	Seeps (-)	Total
April	2109.9	1121.8	1006.4	-1994.5
May	3978.0	1710.4	973.4	-3241.0
June	4850.2	1995.6	1006.4	-3860.9
July	4943.0	2011.0	973.4	-3905.4
August	2659.8	1265.9	973.4	-2367.3
September	1231.2	848.4	1006.2	-1389.1
October	875.2	681.1	973.2	-1167.4
November	268.9	576.2	1018.0	-710.8
December	429.2	2318.5	633.9	+1255.4

3.6 CONTROL STRUCTURES

Permanent gates and temporary barriers represented in the model include the Delta Cross Channel, Old River near Tracy (DMC) barrier, Old River at Head barrier, Middle River barrier, Montezuma Slough salinity control gates, Grant Line Canal barrier, Lawler buffer ditch culvert. Control structure locations are shown in Figure 3-6. The control structures are represented as follows.

- **Delta Cross –** a single operable gate 120’ wide.
- **Old River near Tracy (DMC) temporary barrier –** six circular culverts with tide gates and a single weir. The culverts are 4’ diameter and 56’ long with a Manning’s n value of 0.02 and invert elevation of -6’ MSL. The weir is 75’ wide with a crest elevation of 2’ NGVD.
- **Old River at Head temporary barrier –** Spring operation: six circular culverts and a single weir. The culverts are 4’ diameter and 56’ long with a Manning’s n value of 0.02 and invert elevation of -4’ MSL. The weir is 200’ wide with a crest elevation of 10’ NGVD. Fall operation: six circular culverts and a single weir. The culverts are 4’ diameter and 56’ long with a Manning’s n value of 0.02 and invert elevation of -5’ MSL. The weir is 32’ wide with a crest elevation of 0’ NGVD.

- **Middle River temporary barrier –** six circular culverts with tide gates and a single weir. The culverts are 4’ diameter and 40’ long with a Manning’s n value of 0.02 and invert elevation of -4’ MSL. The weir is 140’ wide with a crest elevation of 1’ NGVD.
- **Montezuma Slough salinity control gates** – three operable tide gates and a flashboard structure. The gates are each 36’ wide and the flashboard is 66’ wide. The flashboard structure is either in or out (no partial installation during this period).
- **Grant Line Canal temporary barrier –** six circular culverts with tide gates and a single weir. The culverts are 4’ diameter and 40’ long with a Manning’s n value of 0.02 and invert elevation of -6.5’ MSL. The weir is 125’ wide with a crest elevation of 0.5’ NGVD.
- **Lawler buffer ditch culvert –** a single circular culvert. The culvert is 2.8’ diameter and 69’ long with a Manning’s n value of 0.024 and invert elevation of -3’ MSL.
- **Rock Slough tide gate –** permanent tide gate.

The simulation period operation schedule for the Delta Cross Channel is detailed in Table 3-2. Temporary barrier operations are given in Table 3-3. The Montezuma Slough salinity control gate operation schedule is detailed in Table 3-4. The gate status “Closed” means no flow is passing through the Gate. “Open” means the gate is not affecting flow in the channel. “Operating” means the gate is affecting flow based on specified components (weirs, culverts or tide gates) and their associated parameters.

Gate and barrier operations data are provided by DWR and IEP.

Table 3-2 Delta Cross Channel gate calibration period operation schedule.

Date	Hour	Gate status
01Jan2002	0.00	Closed
24May2002	10.40	Operating
28May2002	10.40	Closed
31May2002	10.40	Operating
03Jun2002	20.28	Closed
04Jun2002	5.50	Operating
04Jun2002	20.50	Closed
05Jun2002	5.50	Operating
05Jun2002	20.50	Closed
06Jun2002	5.50	Operating
06Jun2002	20.50	Closed
07Jun2002	5.50	Operating
09Jun2002	23.50	Closed
10Jun2002	7.50	Operating
10Jun2002	23.50	Closed
11Jun2002	7.50	Operating
11Jun2002	23.50	Closed
12Jun2002	7.50	Operating
12Jun2002	23.50	Closed
13Jun2002	7.50	Operating
13Jun2002	23.50	Closed
14Jun2002	7.50	Operating
16Oct2002	8.50	Closed
19Oct2002	8.00	Operating
12Nov2002	8.25	Closed
12Nov2002	17.50	Operating
03Dec2002	10.20	Closed
10Dec2002	14.00	Operating
16Dec2002	11.50	Closed
31Dec2002	24.00	Closed

Table 3-3 Temporary barrier calibration period operations schedule.

Barrier	Spring Installation	Spring Removal	Fall Installation	Fall Removal
ROLD046	15Apr2002	–	–	29Nov2002
Old River at Head	15Apr2002	25May2002	04Oct2002	23Nov2002
RMID023	15Apr2002	–	–	21Nov2002
Grant Line Canal	07Jun2002* 16Jun2002**	–	–	25Nov2002

* flap gates tied open
** flap gates begin operating

Table 3-4 Montezuma Slough salinity control gate calibration period operation schedule.

Date	Gate Status	Flashboard Status
01Jan2002	Operating	In
17Jan2002	Open	In
06May2002	Open	Out
28Sep2002	Operating	In
31 Dec2002	Operating	In

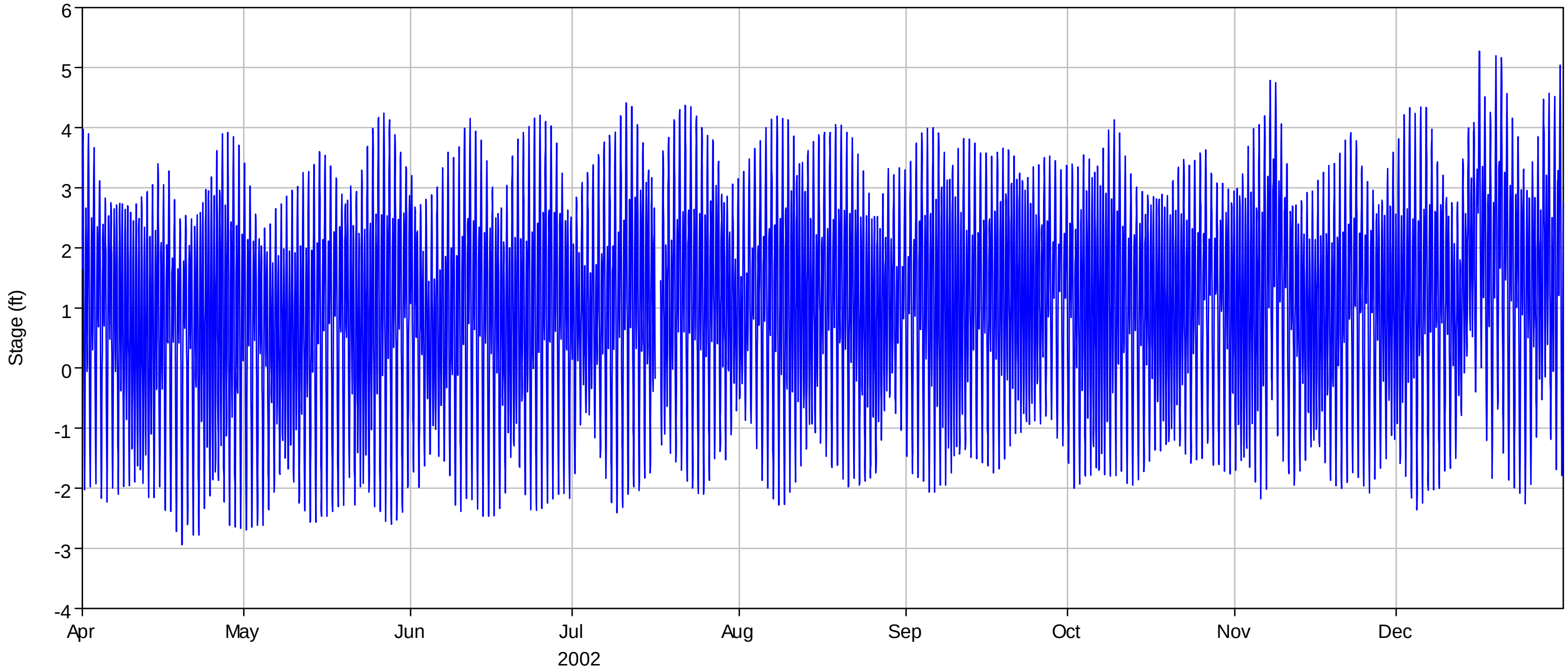

Figure 3-1 Simulation period stage at Martinez.

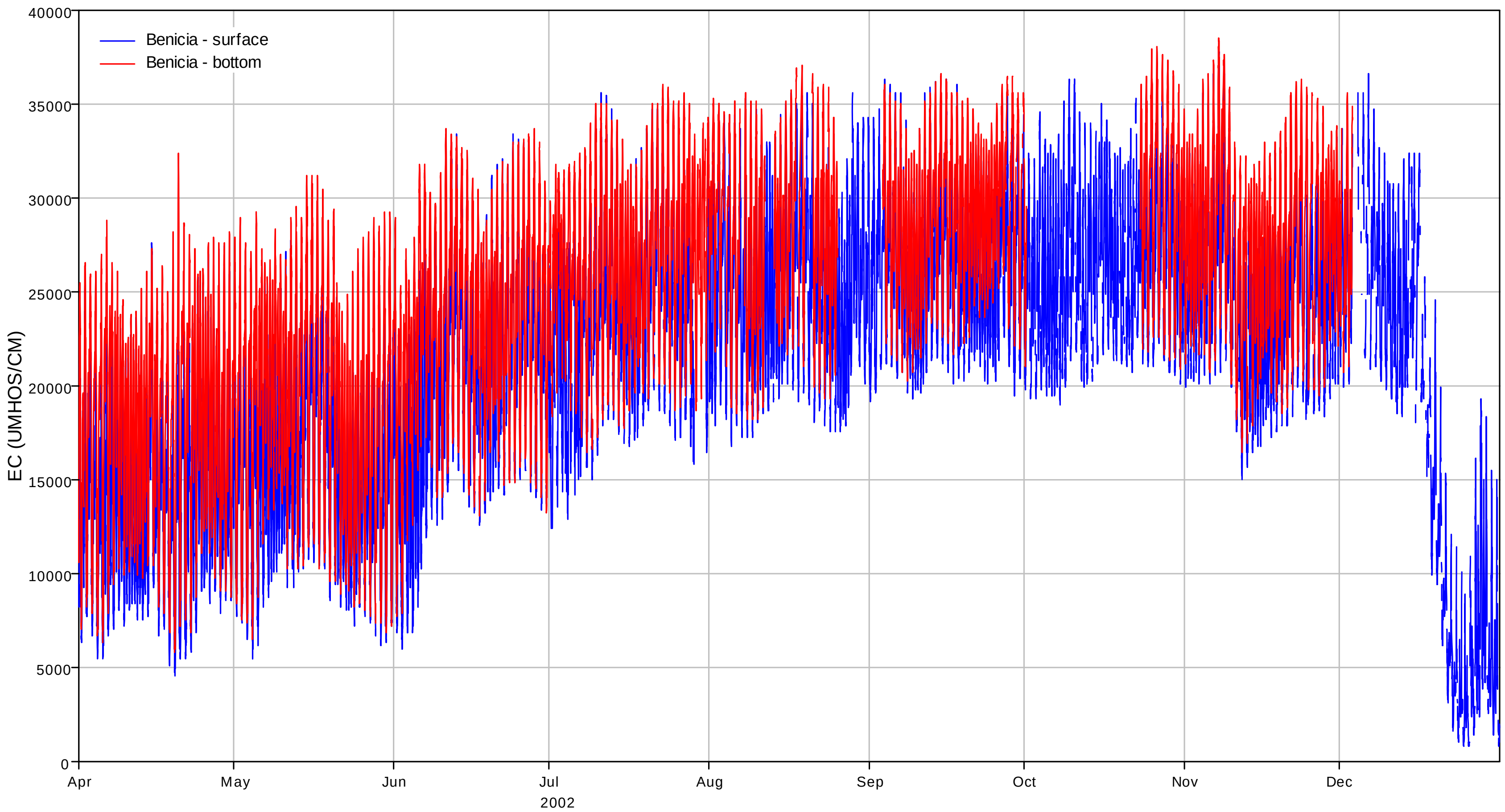

Figure 3-2 Top and bottom EC at Benicia Bridge (USGS data).

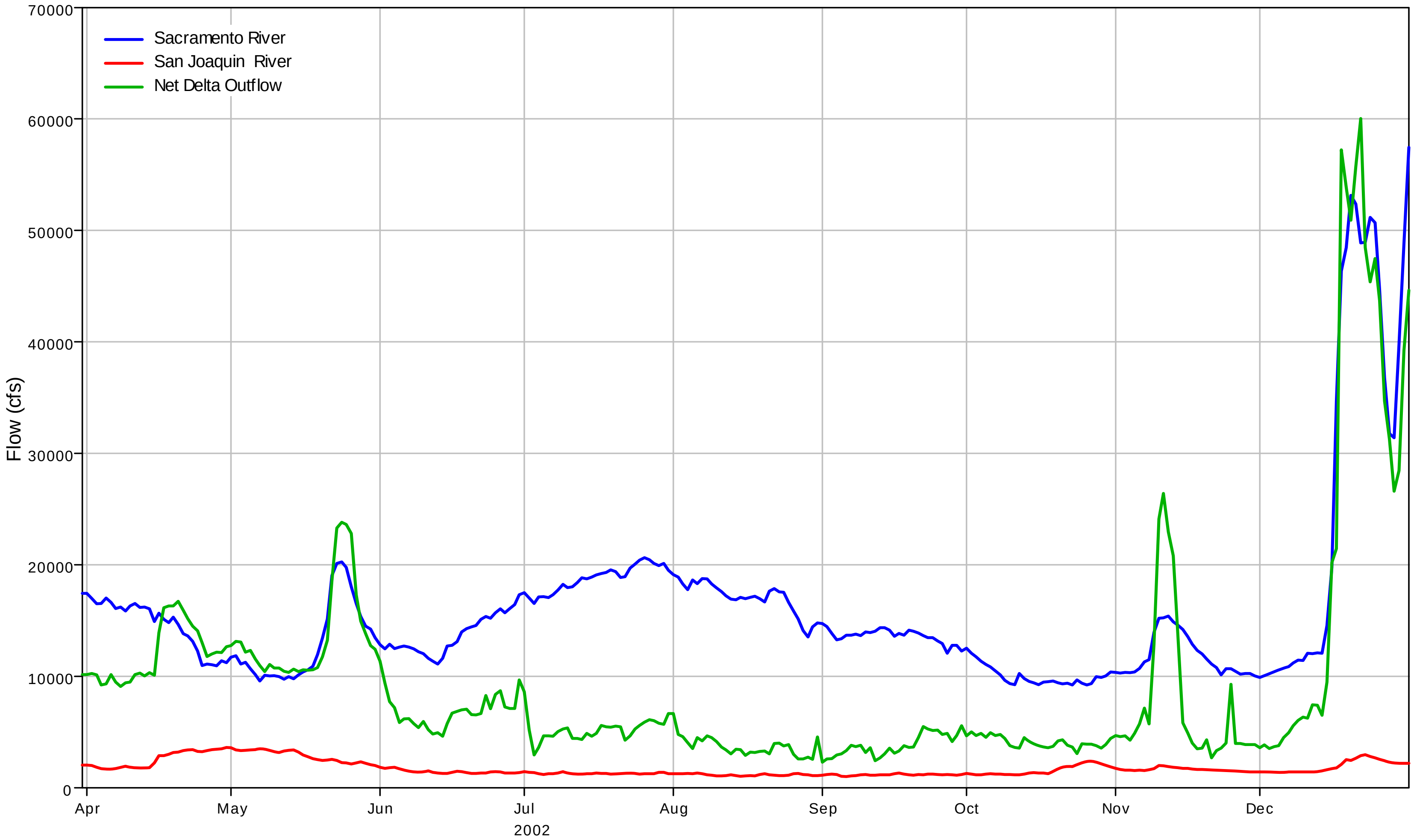

Figure 3-3 Simulation period river flows and Net Delta Outflow.

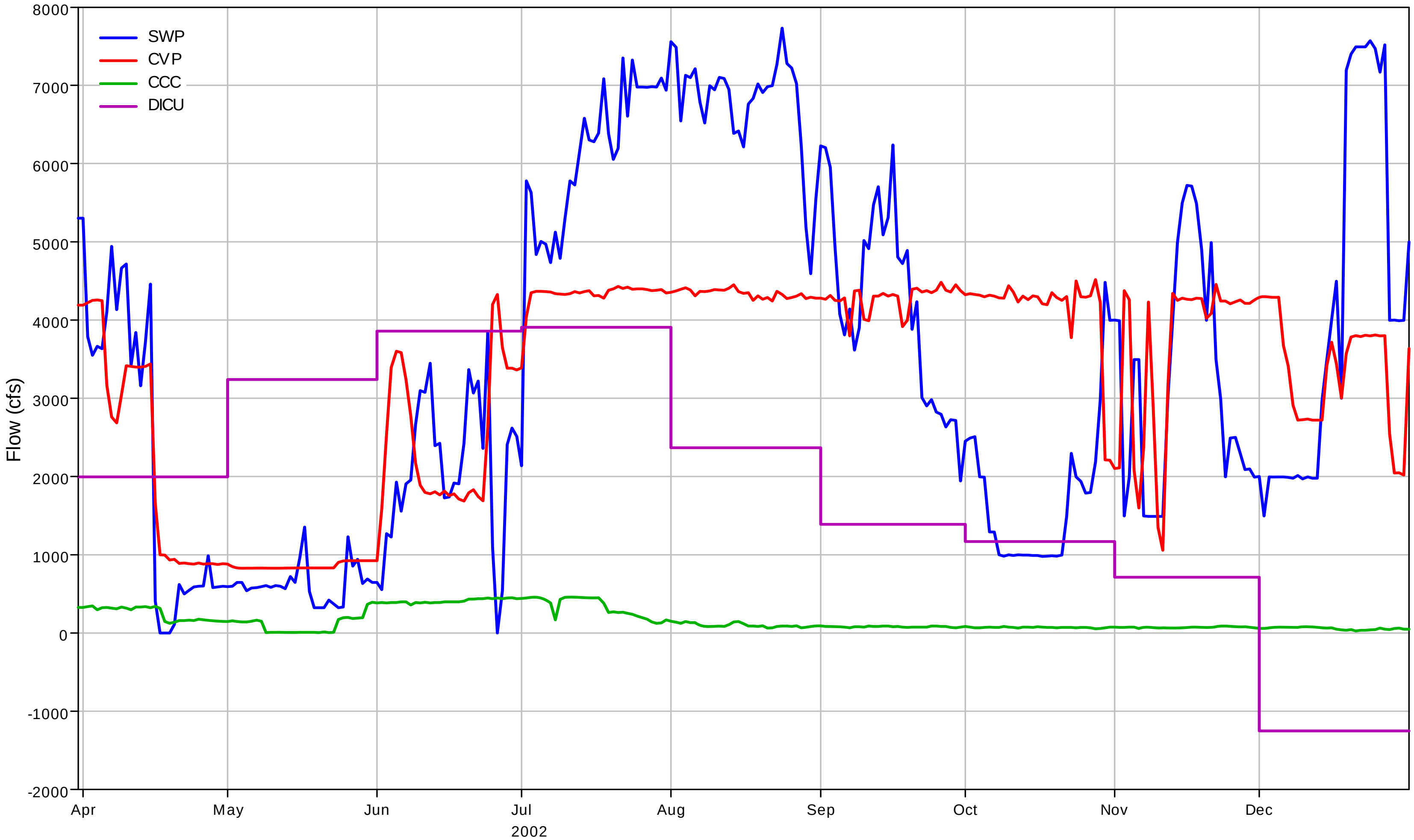

Figure 3-4 Calibration period exports and net DICU flows.

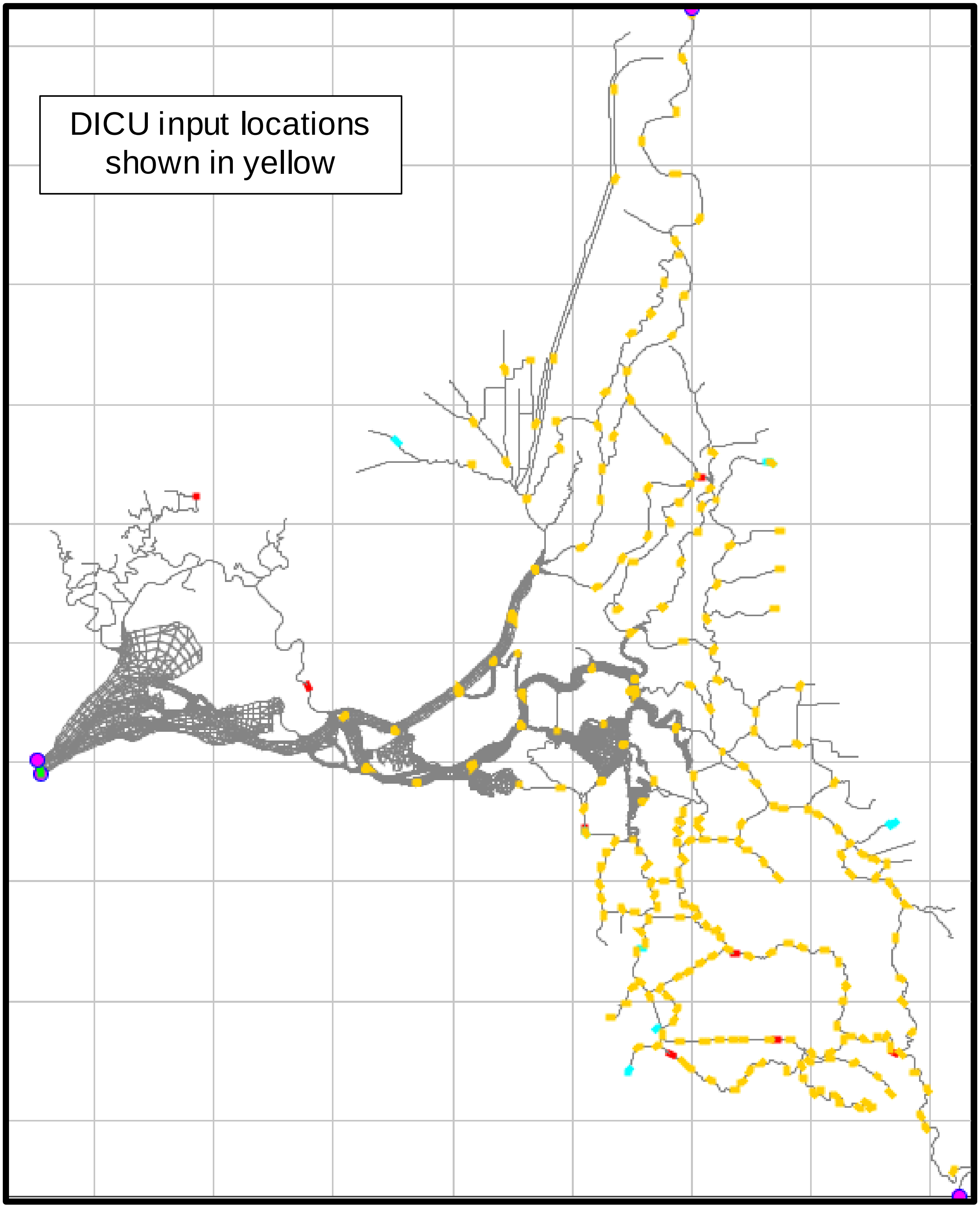

Figure 3-5 DICU input locations.

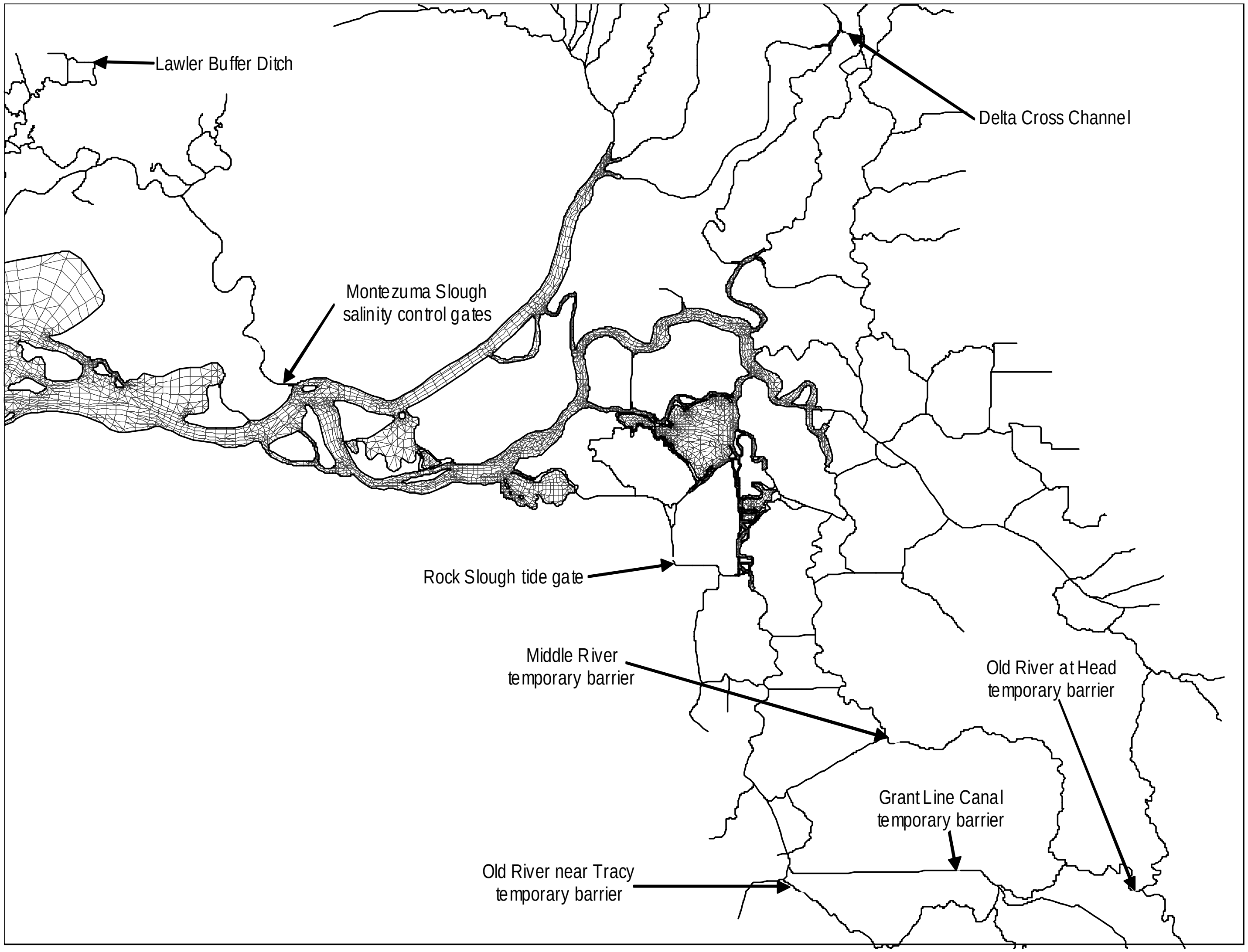

Figure 3-6 Control structure locations.

4 EC RESULTS

Salinity is typically monitored using the surrogate measure of electrical conductivity (EC) measured in μmhos/cm.

Tidally averaged EC time series are provided in Figures 4-1 through 4-12 at the six key locations shown in Figure 4-1: Jersey Point, the Contra Costa intake at Rock Slough, the Contra Costa intake on Old River, RMID023 (Middle River at Victoria Island), the SWP intake, and the CVP intake. There are two plots for each location. The first plot compares the Base case with the following alternatives: "No Franks Tract", "East Side Open", "Cox", "West False River Gate", and "West False River Gate 1/3 Flow". In the second plot, the Base case results are plotted with the remaining alternatives: "False River and Piper Slough Gates", "North Levee and Nozzle Gate", "North Levee, Nozzle Gate and Piper Slough Gate", "East Levee and Gates", and "North Levee and Close Little Franks Tract".

The "East Levee and Gates" alternative generally produces the lowest EC values at the intakes (all key locations except RMID023 and Jersey Point). Other alternatives resulting in significant reductions at the intakes are: "East Side Open", "Cox Alternative" and "West False River Gate 1/3 Flow". The "No Franks Tract" alternative is the only alternative that results in reduced EC values at RMID023 throughout most of the simulation period. At Jersey Point, the most significant EC reductions are achieved with the two "West False River Gate" alternatives, the "False River and Piper Slough Gates" alternative, and the "North Levee, Nozzle Gate and Piper Slough Gate" alternative.

Tidally averaged EC concentration contours at the beginning of each month are provided in Figures 4-13 through 4-26 for the Base case and each of the alternatives. There are two plots for each month. The first plot shows the Base case with the following alternatives: "No Franks Tract", "East Side Open", "Cox", and "West False River Gate". In the second plot, the Base case results are shown with the remaining alternatives: "False River and Piper Slough Gates", "North Levee and Nozzle Gate", "North Levee, Nozzle Gate and Piper Slough Gate", "East Levee and Gates", and "North Levee and Close Little Franks Tract".

Summary tables of peak tidally averaged EC and percent decrease below Base case at key locations are provided for each month from May through December 2002 in Tables 4-1 through 4-8. Summary tables of monthly averaged EC and percent decrease below Base case at key locations are provided for each month from May through December 2002 in Tables 4-9 through 4-16.

4.1 NO FRANKS TRACT

The "No Franks Tract" alternative results in reduced EC at nearly all locations throughout the Delta during July through November. This is the only alternative that results in EC decreases at RMID023.

At the SWP intake, reductions in monthly peak tidally averaged EC range from 6 to 8% during this period. At the CVP intake, the reductions range from 5 to 6%. At the Contra Costa intakes at Old River and Rock Slough, reductions range from 9 to 11% and 7 to 10%, respectively. At Jersey Point, reductions range from 4 to 7% and at RMID023, reductions range from 1 to 2%.

Although this alternative reduces south Delta salinity, other alternatives perform better. False River remains a direct conduit of high salinity water to Old River. In addition, in its current state Franks Tract begins the summer period as a reservoir of fresh water in the central Delta and initially dilutes the higher salinity water entering from the western Delta.

This is a "bookend" alternative only and is not considered as a possibility for implementation.

4.2 EAST SIDE OPEN

The "East Side Open" alternative results in some of the largest reductions in EC at all key locations except Jersey Point and RMID023. At the SWP intake, reductions in monthly peak tidally averaged EC range from 12 to 16% during July through November. At the CVP intake, the reductions range from 6 to 12%. At the Contra Costa intakes at Old River and Rock Slough, reductions range from 18 to 22% and 21 to 24%, respectively. At Jersey Point, reductions range from 5 to 8%. At RMID023, monthly peak tidally averaged EC values are increased by 0 to 4%.

This alternative keeps the high salinity waters of the western Delta from entering and mixing in Franks Tract. This leads to a lower salinity in Old River south of Franks Tract. Salinity in Middle River is only slightly higher relative to the Base configuration.

4.3 COX ALTERNATIVE

The "Cox Alternative" results in some of the largest reductions in EC at the Contra Costa intakes. EC is increased with this alternative at RMID023.

At the SWP intake, reductions monthly peak tidally averaged EC range from 10 to 13% during July through November. At the CVP intake, the reductions range from 2 to 9%. At the Contra Costa intakes at Old River and Rock Slough, reductions range from 17 to 22% and 22 to 29%, respectively. At Jersey Point, reductions range from 0 to 6%. At RMID023, monthly peak tidally averaged EC values are increased by 9 to 19%.

In this alternative, salinities in Franks Tract are not reduced and may be slightly higher than the Base condition. The Cox barriers appear to effectively isolate Old River from Franks Tract waters. However, much of the higher salinity water moving through Franks Tract flows to the Middle River, increasing salinities there. Salinities on Old River and Middle River in the south Delta are roughly the same.

4.4 WEST FALSE RIVER GATE

The "West False River Gate" alternative results in some of the largest reductions in EC at Jersey Point. At the remaining key locations, this alternative generally produces moderate decreases through September and then EC values begin to rise through December relative to the Base case. EC values at RMID023 are increased above Base case values from July through December.

At the SWP intake, monthly peak tidally averaged EC values are reduced by 11 to 14% during July through September, reduced by 7% in October and are increased above the Base case by 3% in November. At the CVP intake, EC is reduced by 6 to 9% from July through October, and are increased by 7% in November. At the Contra Costa intake at Old River, EC is reduced by 16 to 21% during July through October, and by 3% in November. At the Contra Costa intake at Rock Slough, reductions range from 22 to 24% during July through October, and drop to 7% in November. At Jersey Point, reductions range from 34 to 41% during July through November. At RMID023, monthly peak tidally averaged EC values are increased by 9 to 19% during July through November.

Figure 4-28 presents the difference between the "West False River Gate" alternative and the Base condition monthly average July 2002 flows. With this alternative, the gate is open only on ebb tide. As the figure shows, this introduces a major net clockwise circulation, with net flow west out of False River and up the San Joaquin River over the top of Bradford Island and Webb Tract, with about 25% of the flow reentering False River along Fisherman's Cut and another 55% entering northeast Franks Tract from the San Joaquin River along Old River. As Figure 4-16 indicates, this circulation keeps the salinity along the path comparatively uniform. During June through September, this serves to reduce salinity in Franks Tract and thus Old River and the export locations. Near the middle of October, this benefit is lost (Figure 4-22) as salinity in Old River near the south Delta export locations increases above the Base condition values.

This salinity reduction at the exports in the summer months, with the corresponding salinity increase during the fall months is likely due partly to other changes in the net flows in the western and central Delta with implementation of this alternative. Figure 4-28 shows an increase in average flow in the downstream direction for the San Joaquin River at Jersey Point. About 60% of this flow change is redirected up the Sacramento River (near Emmaton). The result of the net flow change is to block the higher salinity water moving up from Suisun Bay on the San Joaquin River, but to also increase the net movement upstream of the high salinity water on the Sacramento River. Relative to the Base condition, salinity is lower at Jersey Point, but higher at Emmaton. Of the 1680 cfs net change on the Sacramento River (Figure 4-28), about two-thirds flows from the Sacramento River to the San Joaquin River via Three Mile Slough. In the summer months, the Sacrament River at Three Mile Slough is fresher relative to the San Joaquin at Jersey Point. Thus the additional flow of fresh water from the Sacramento River reduces the salinity in the central Delta. Beginning in October, the salinity in the Sacramento River is higher, and this higher salinity water is pumped along Three Mile Slough into the central Delta. The higher salinity water entering the San Joaquin River from Three Mile Slough is quickly mixed into Old River by the major clockwise circulation described earlier.

Another notable change in the net circulation is the additional approximately 2400 cfs flow along the San Joaquin River, east of Franks Tract, down the Middle River and returning to Franks Tract by way of Connection Slough, Old River and Holland Cut (Figure 4-28). This flow change pushes higher salinity water south on the San Joaquin River, into Middle River and tends to increase overall salinity in Middle River further south in the Delta.

4.5 WEST FALSE RIVER GATE 1/3 FLOW

With the West False River gate 1/3 open on the ebb tide, EC results tend to be lower than with the gate fully open on ebb tide, except at Jersey Point. The rise in EC relative to the Base case between October and December, which is seen in the fully open case, is not as apparent with the gate 1/3 open.

At the SWP intake, reductions in monthly peak tidally averaged EC range from 15 to 18% during July through October and drop to 9% in November. At the CVP intake, the reductions range from 11 to 13% from July through October, and drop to 2% in November. At the Contra Costa intake at Old River, reductions range from 22 to 24% during July through October, then drop to 16% in November. At the Contra Costa intake at Rock Slough, reductions range from 26 to 27% during July through October, and drop to 22% in November. At Jersey Point, reductions range from 24 to 28% during July through November. At RMID023, tidally averaged EC values are increased by 5 to 8% during July through November.

Relative to the Base condition, this alternative greatly reduces the tidal flow in and out of Franks Tract. The result is to reduce the mixing of higher salinity water from the western Delta into Franks Tract. This alternative reduces the strong clockwise net circulation seen in the full gate flow alternative, thus reducing the degree of salinity mixing between the waters west and east of Franks Tract. In the fall months, the reduced gate flow alternative also reduces the migration of high salinity water up the Sacramento River, through Three Mile Slough into the San Joaquin River north of Franks Tract.

4.6 FALSE RIVER AND PIPER SLOUGH GATES

This alternative results in some of the largest reductions in EC at Jersey Point and some of the largest increases in EC at RMID023. At the remaining key locations, EC values for this alternative are generally below Base case values. At the SWP and CVP intakes, EC rises above Base values near the end of October through the end of the simulation.

At the SWP intake, reductions in monthly peak tidally averaged EC range from 7 to 12% during July through October. In November peak tidally averaged EC is increased by 2%. At the CVP intake, the reductions range from 4 to 8% during July through October. In November peak tidally averaged EC is increased by 7%. At the Contra Costa intake at Old River, reductions range from 15 to 19% during July through October, then drop to 3% in November. At the Contra Costa intake at Rock Slough, reductions range from 21 to 23% during July through October, and drop to 8% in November. At Jersey Point, reductions range from 33 to 39% during July through November. At RMID023, monthly peak tidally averaged EC values are increased by 13 to 20% during July through November.

The salinity regime developed by this alternative is similar to the West False River Gate (full flow) alternative.

4.7 NORTH LEVEE AND NOZZLE GATE

The “North Levee and Nozzle Gate” alternative results in small decreases in EC in Old River, Rock Slough, at the SWP intake and Jersey Point. At CVP, tidally averaged EC fluctuates slightly above and below Base values throughout most of the simulation. At RMID023, the “North Levee and Nozzle Gate” alternative increases EC above Base values. Near the end of October, EC values increase relative to Base values at Old River, Rock Slough and the SWP intake.

At the SWP intake, reductions in peak tidally averaged EC range from 3 to 5% during July through October. In November peak tidally averaged EC is unchanged from the Base case. At the CVP intake, EC values range from 3% below Base values to 3% above during July through November. At the Contra Costa intake at Old River, reductions range from 7 to 11% during July through October, then drop to 5% in November. At the Contra Costa intake at Rock Slough, reductions range from 12 to 13% during July through October, and drop to 9% in November. At Jersey Point, reductions range from 8 to 9% during July through November. At RMID023, monthly peak tidally averaged EC values are increased by 13 to 14% during July through November.

While flow into Franks Tract on the north side is reduced, higher salinity water still enters at the west from Piper Slough. The gate at the Nozzle open only on ebb also has some tendency to push higher salinity water from the west Delta over the San Joaquin River north of Franks Tract and eventually down the Middle River. The result of both circumstances is to diminish the salinity reduction at the exports by the fall months.

4.8 NORTH LEVEE, NOZZLE GATE AND PIPER SLOUGH GATE

This alternative behaves very similarly to the "False River and Piper Slough Gates" alternative. Some of the largest reductions in EC at Jersey Point are achieved, as well as some of the largest increases in EC at RMID023. At the remaining key locations, EC values for this alternative are generally below Base case values. At the SWP and CVP intakes, EC rises above Base values near the end of October through the end of the simulation.

At the SWP intake, reductions in monthly peak tidally averaged EC range from 5 to 9% during July through October. In November peak tidally averaged EC is increased by 2%. At the CVP intake, the reductions range from 2 to 4% during July through October. In November peak tidally averaged EC is increased by 7%. At the Contra Costa intake at Old River, reductions range from 13 to 16% during July through October, then drop to 4% in November. At the Contra Costa intake at Rock Slough, reductions range from 19 to 21% during July through October, and drop to 10% in November. At Jersey Point, reductions range from 28 to 32% during July through November. At RMID023, monthly peak tidally averaged EC values are increased by 17 to 20% during July through November.

4.9 EAST LEVEE AND GATES

The "East Levee and Gates" alternative produces some of the lowest EC values for the Contra Costa, SWP and CVP intakes. At Jersey Point, small reductions result and at RMID023, EC values are increased above the Base case.

At the SWP intake, reductions in monthly peak tidally averaged EC range from 15 to 19% during July through November.   At the CVP intake, the reductions range from 7 to 15%. At the Contra Costa intakes at Old River and Rock Slough, reductions range from 21 to 27% and 27 to 31%, respectively. At Jersey Point, reductions range from 6 to 16%. At RMID023, monthly peak tidally averaged EC values are increased by 1 to 8%.

With this alternative, salinity in Franks Tract builds throughout the summer and fall. However, Old River is well isolated from Franks Tract. Salinity along Middle River remains near Base condition values. The gates in False River and Sand Mound Slough were not operated in the simulation. Residence time considerations for Franks Tract may require these gates be operated some time during the tidal cycle.

4.10 NORTH LEVEE AND CLOSE LITTLE FRANKS TRACT

This alternative results in small decreases in EC at the Old River, Rock Slough, SWP and CVP intakes. At Jersey Point there is very little change from Base case values. At RMID023, EC values are among the lowest of the alternatives, but they are still above Base values.

At the SWP intake, reductions in monthly peak tidally averaged EC range from 6 to 8% during July through November. At the CVP intake, EC reductions range from 4 to 6% during July through November. At the Contra Costa intake at Old River, reductions range from 8 to 12% during July through November. At the Contra Costa intake at Rock Slough, reductions range from 9 to 12% during July through November. At Jersey Point, reductions range from 0 to

1% during July through November. At RMID023, monthly peak tidally averaged EC values are increased by 1 to 2% during July through November.

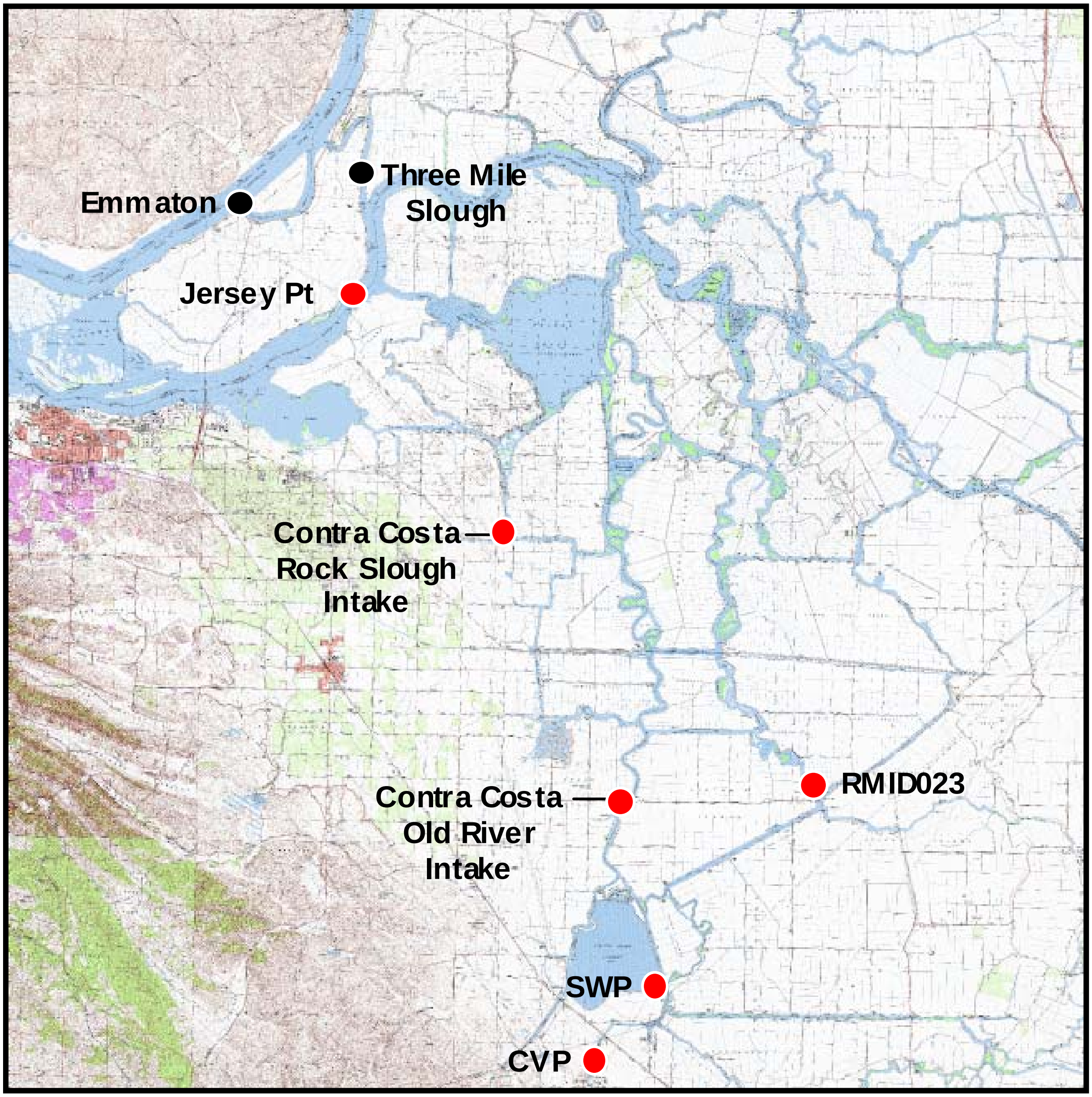

Figure 4-1 EC time series locations.

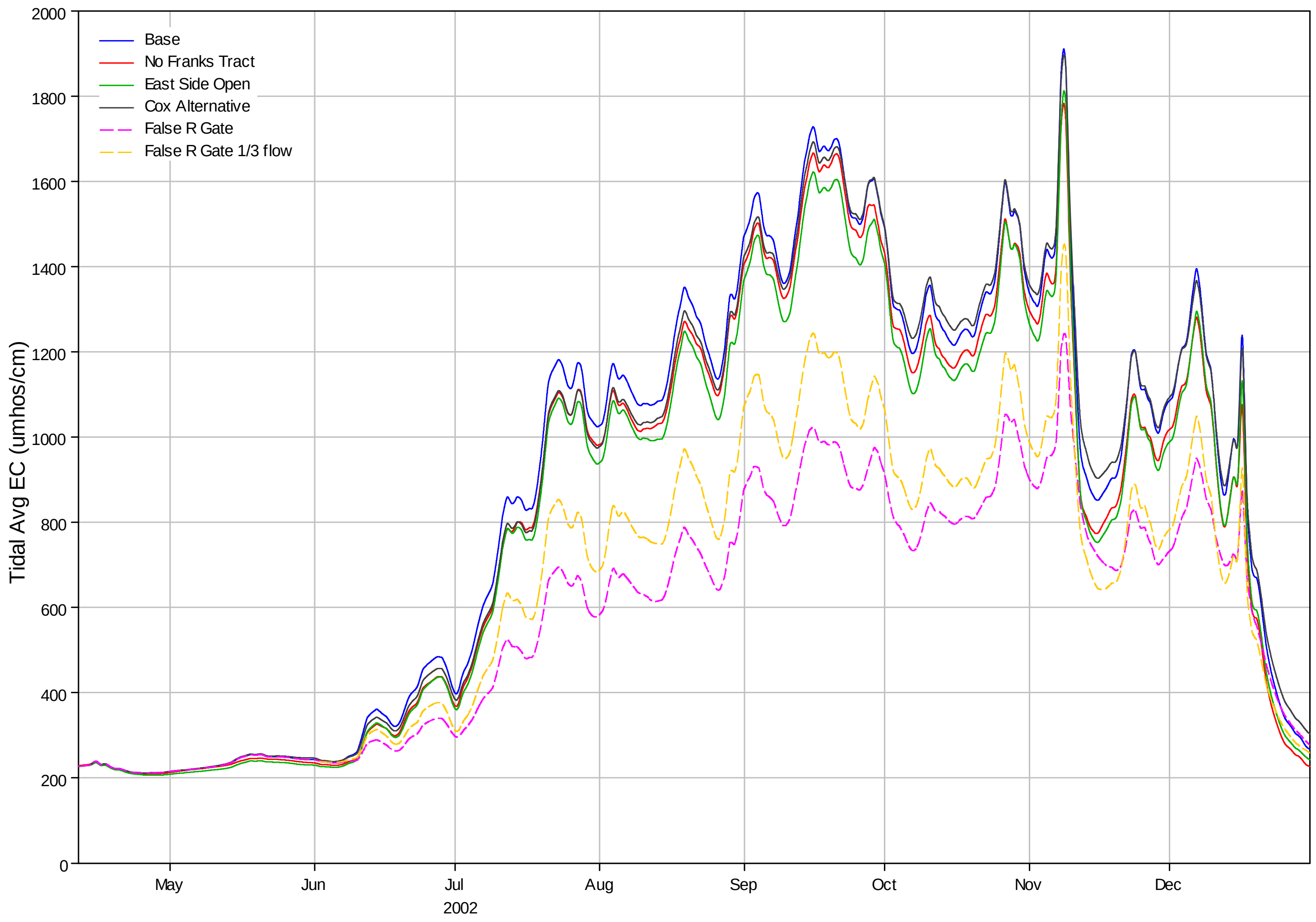

Figure 4-2 Tidally averaged EC results at Jersey Point.

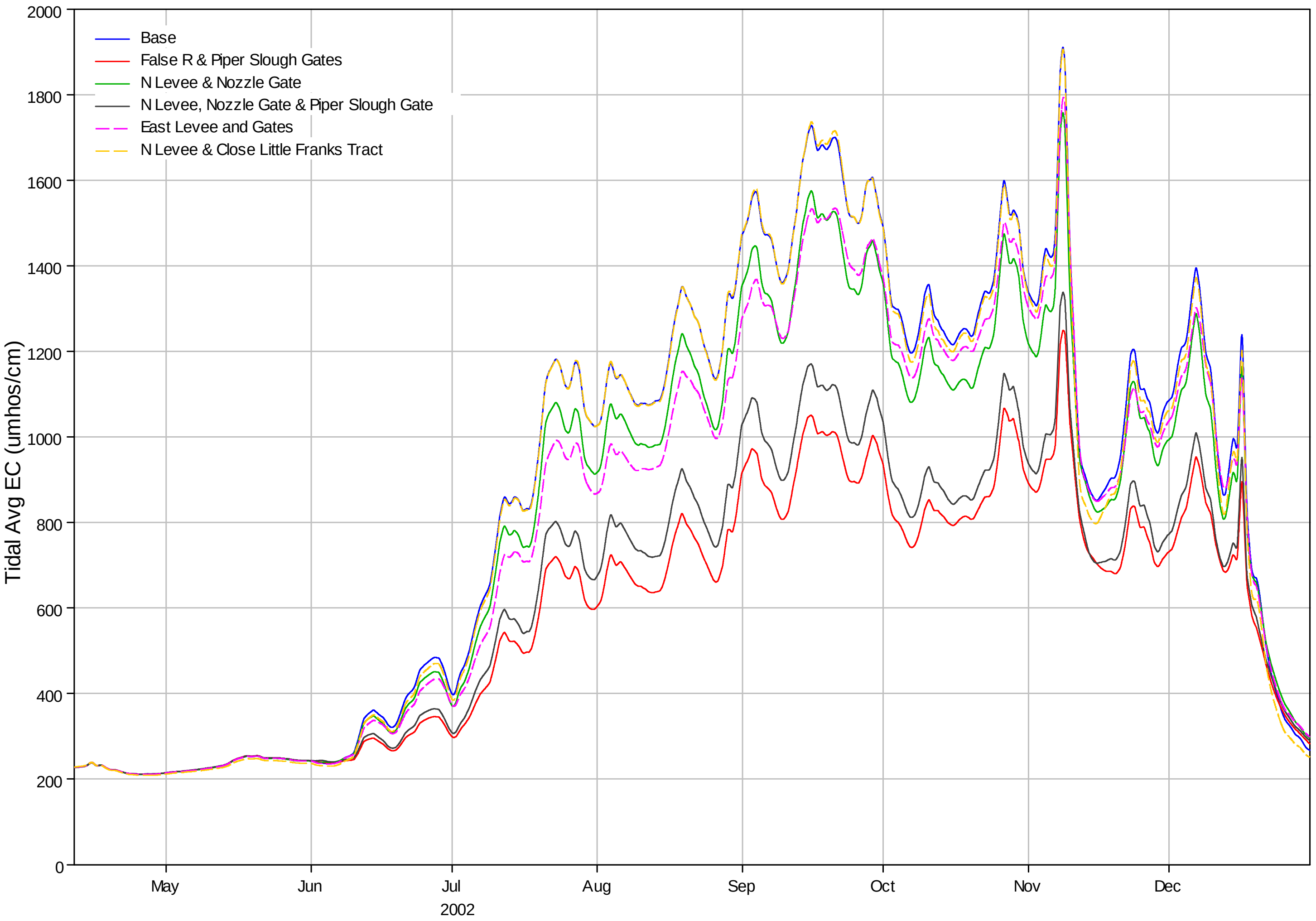

Figure 4-3 Tidally averaged EC results at Jersey Point.

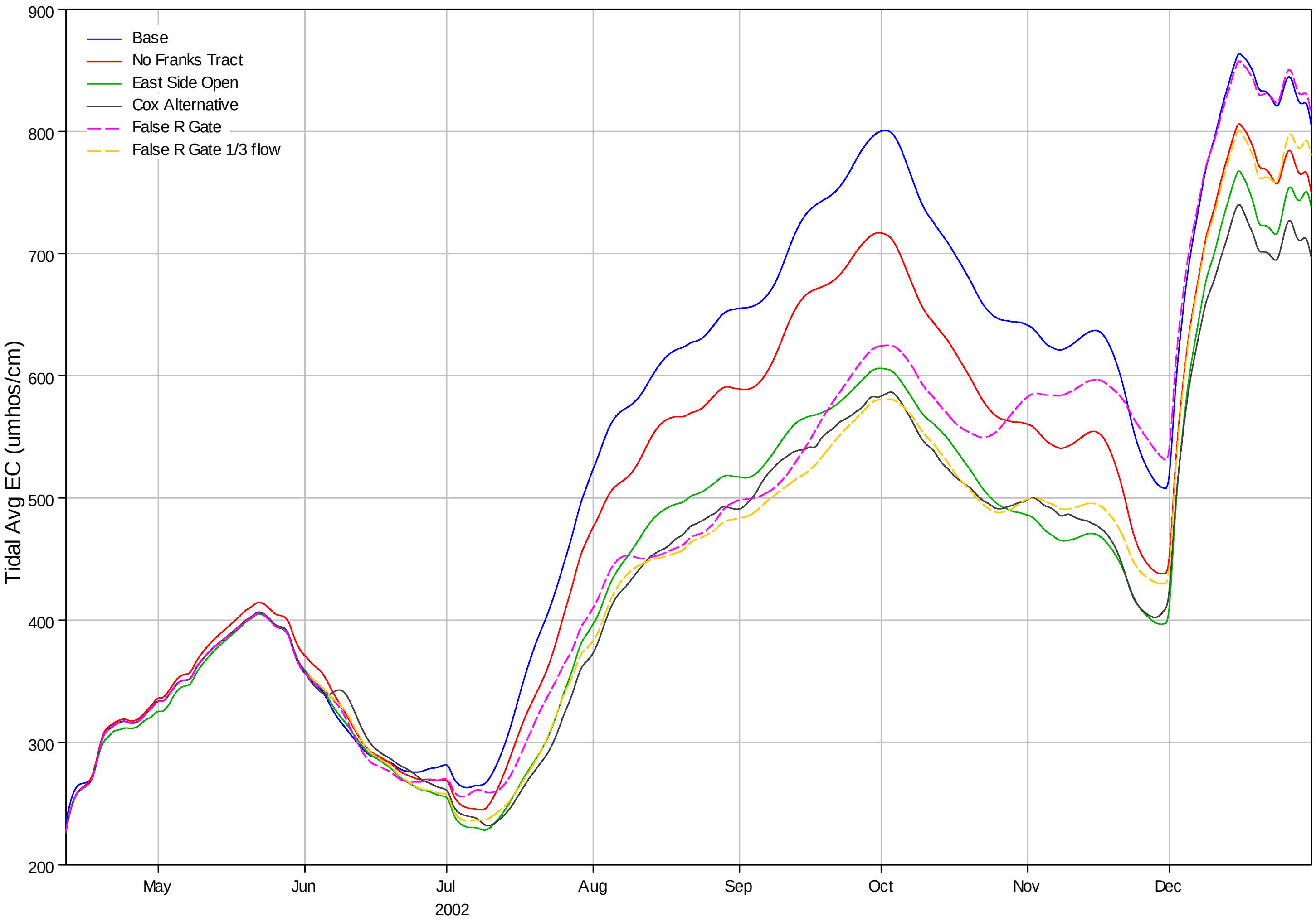

Figure 4-4 Tidally averaged EC results at the Contra Costa intake on Rock Slough.

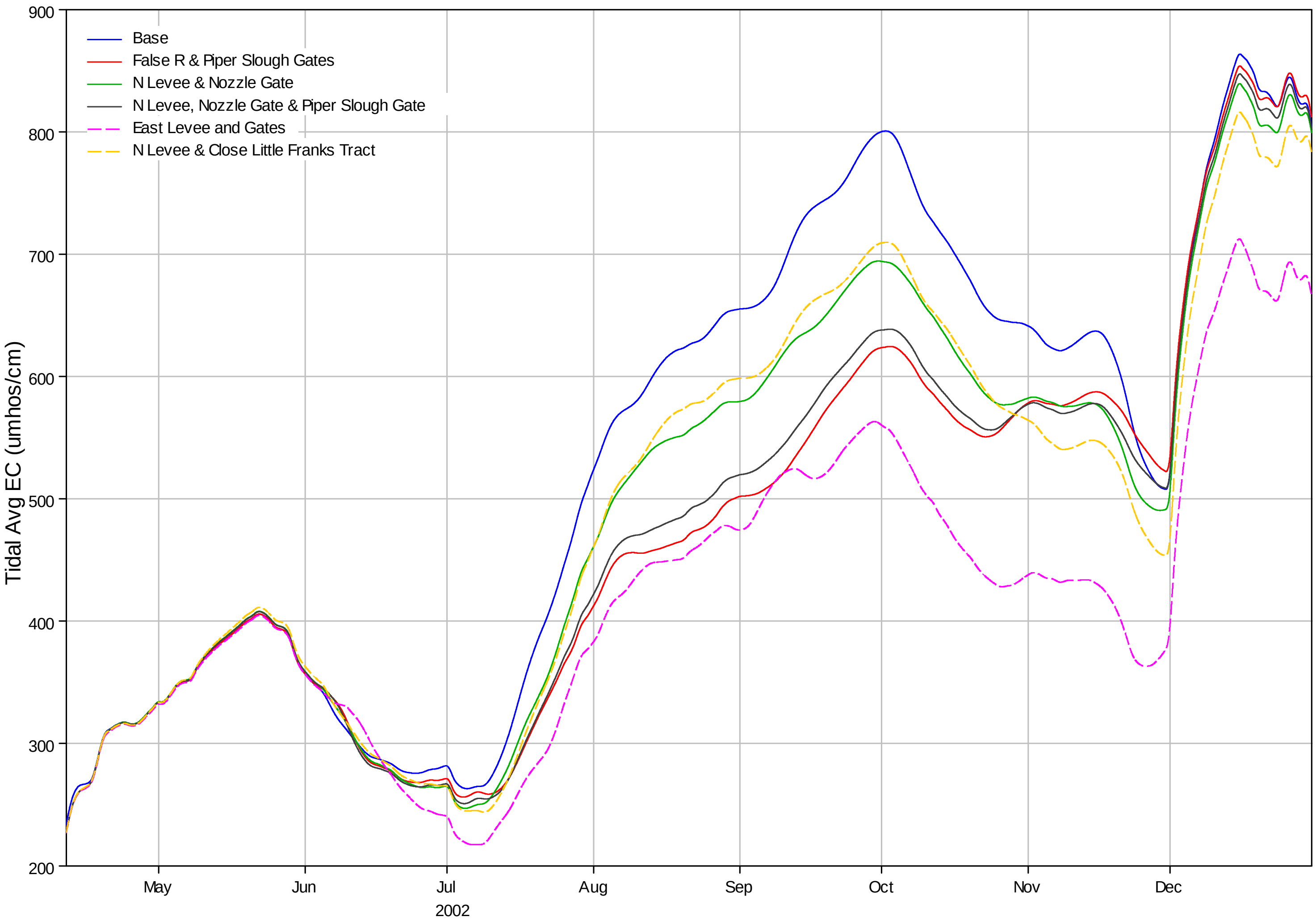

Figure 4-5 Tidally averaged EC results at the Contra Costa intake on Rock Slough.

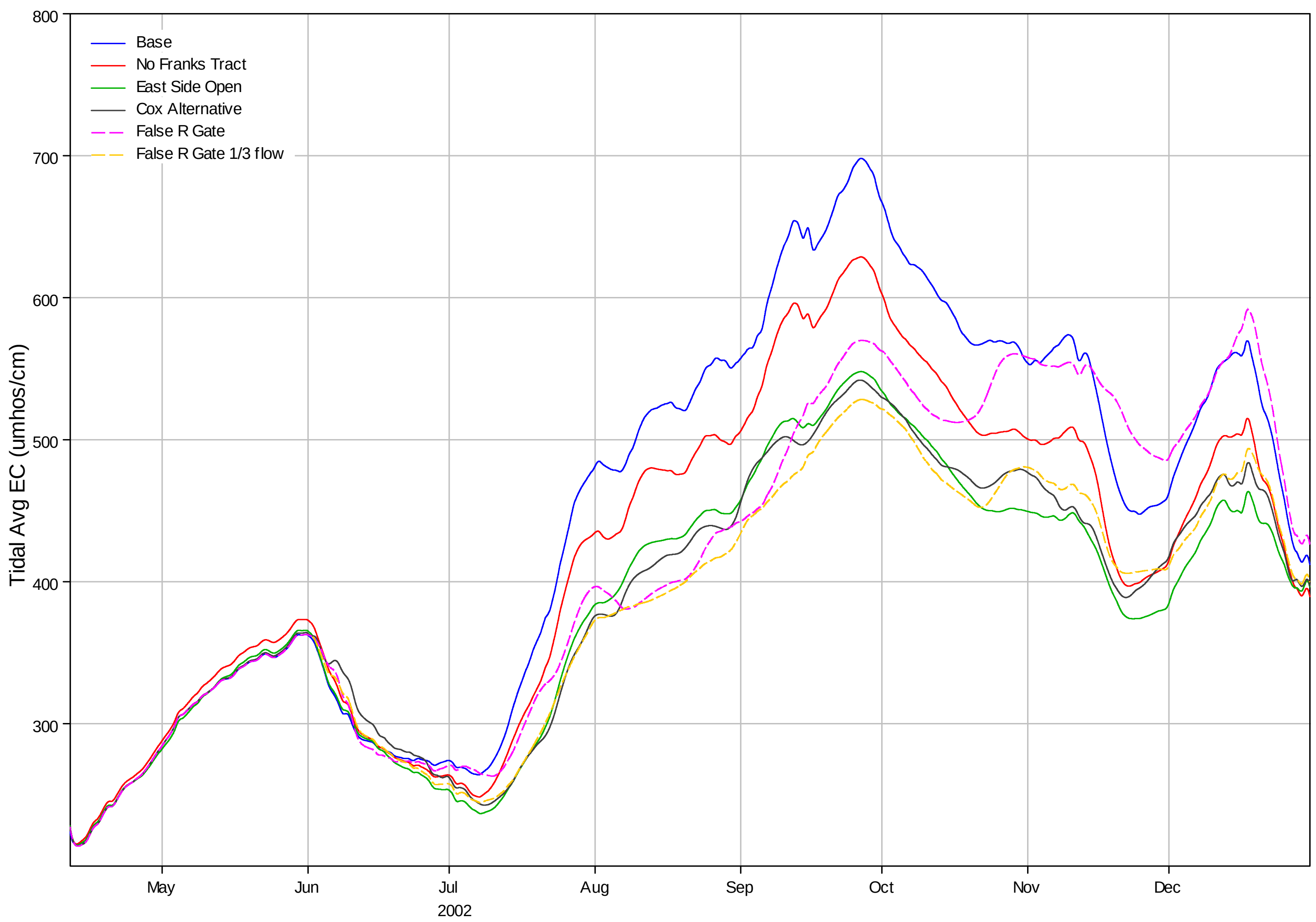

Figure 4-6 Tidally averaged EC results at the Contra Costa intake on Old River.

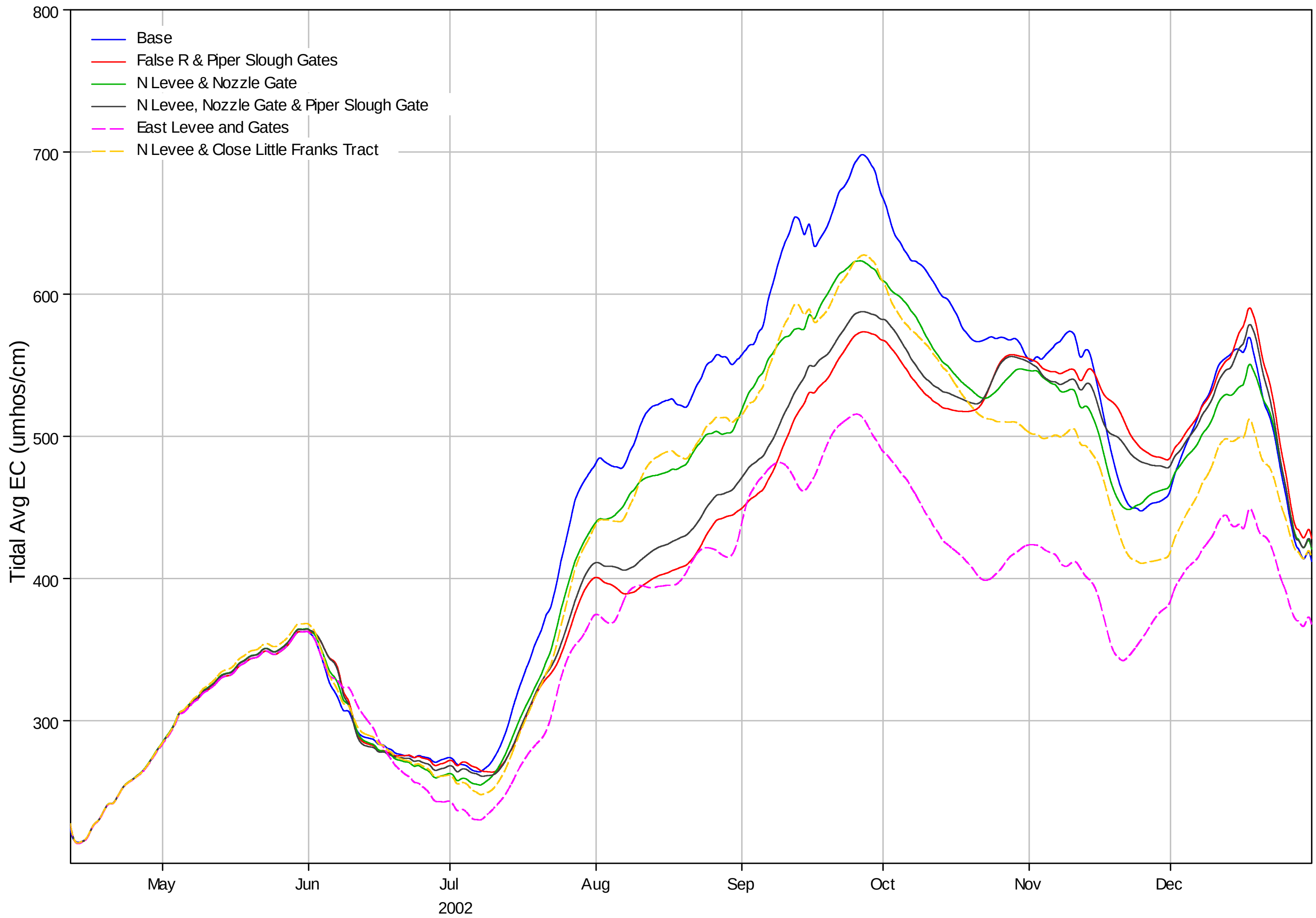

Figure 4-7 Tidally averaged EC results at the Contra Costa intake on Old River.

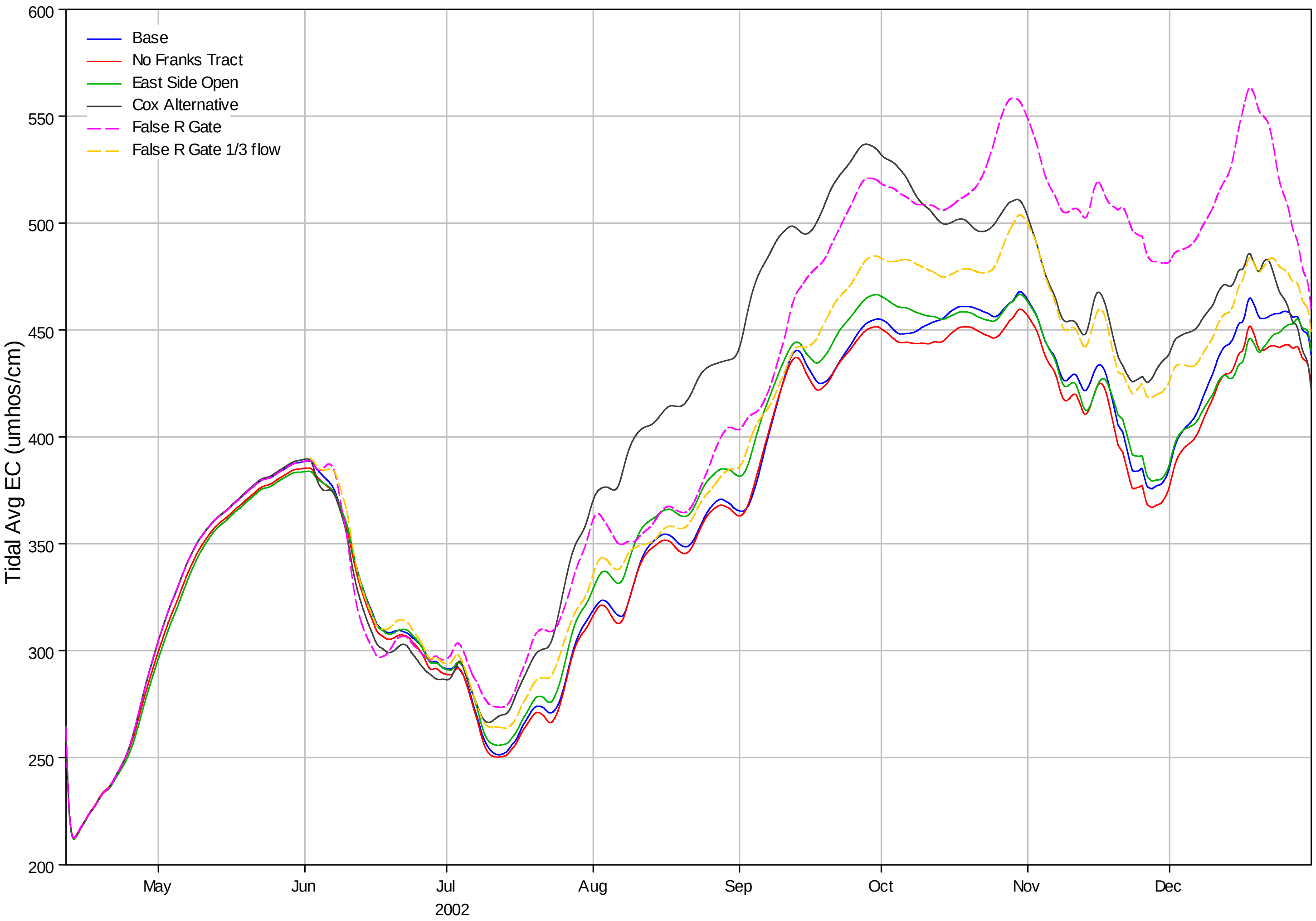

Figure 4-8 Tidally averaged EC results at RMID023.

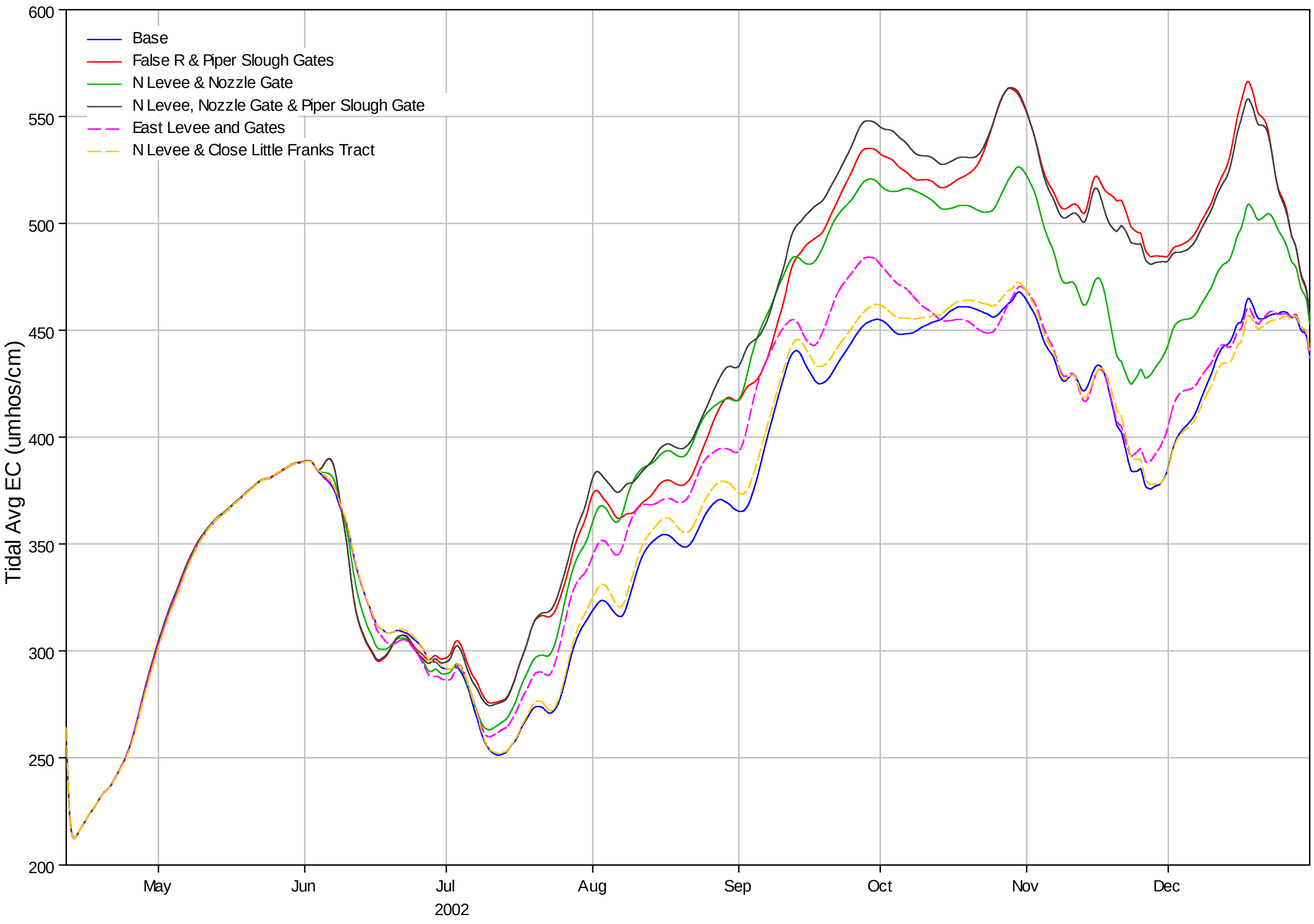

Figure 4-9 Tidally averaged EC results at RMID023.

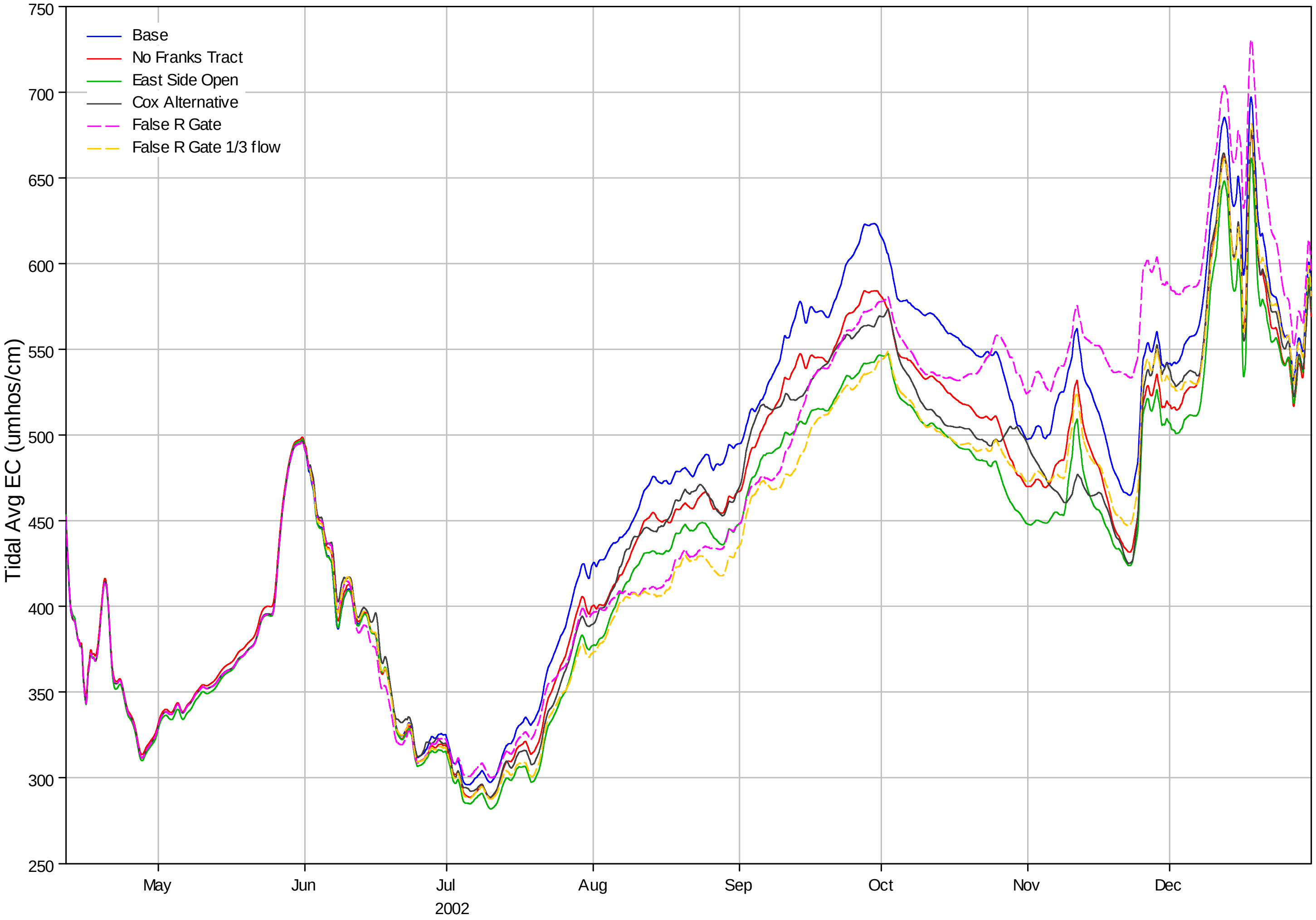

Figure 4-10 Tidally averaged EC results at the CVP intake.

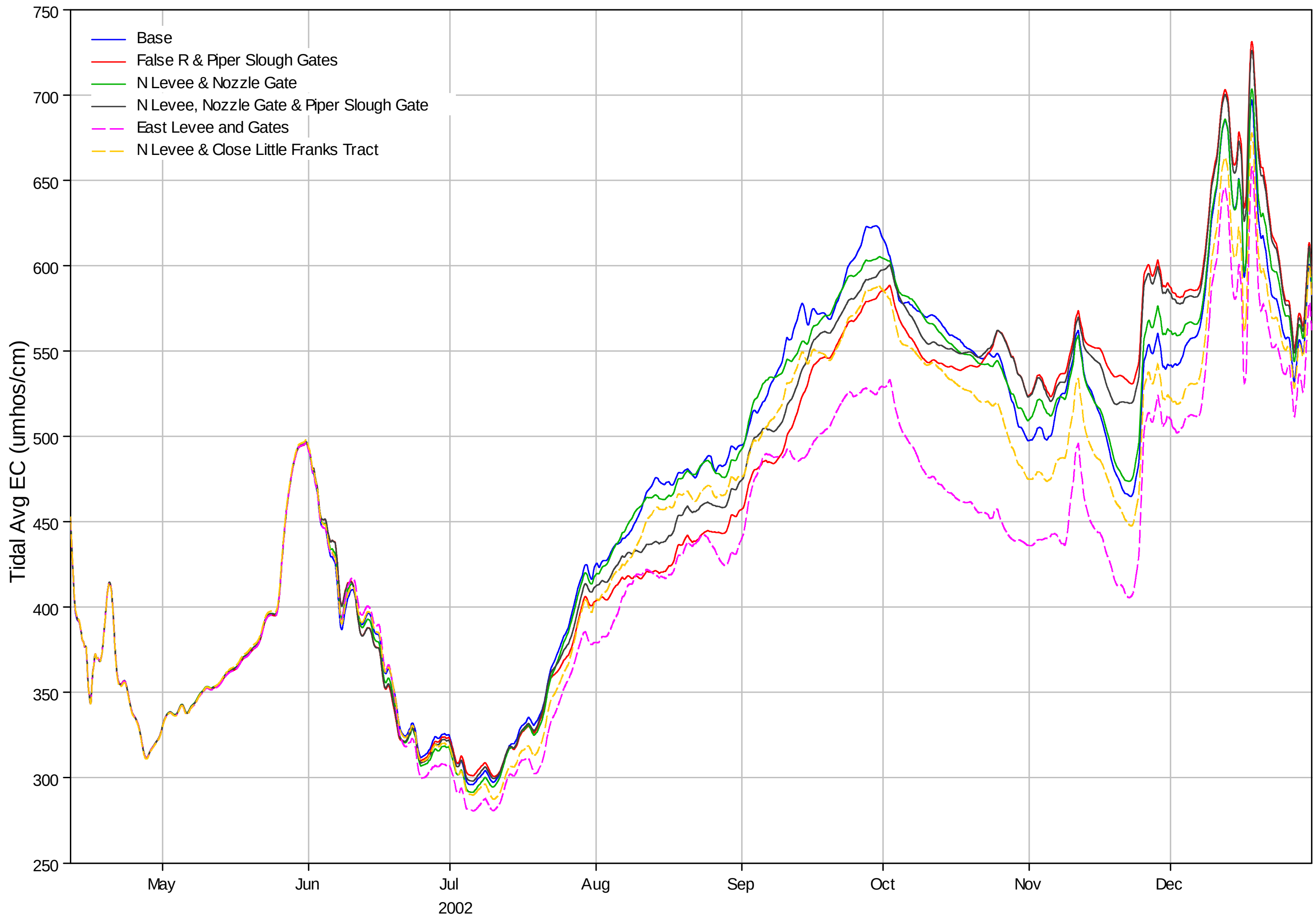

Figure 4-11 Tidally averaged EC results at the CVP intake.

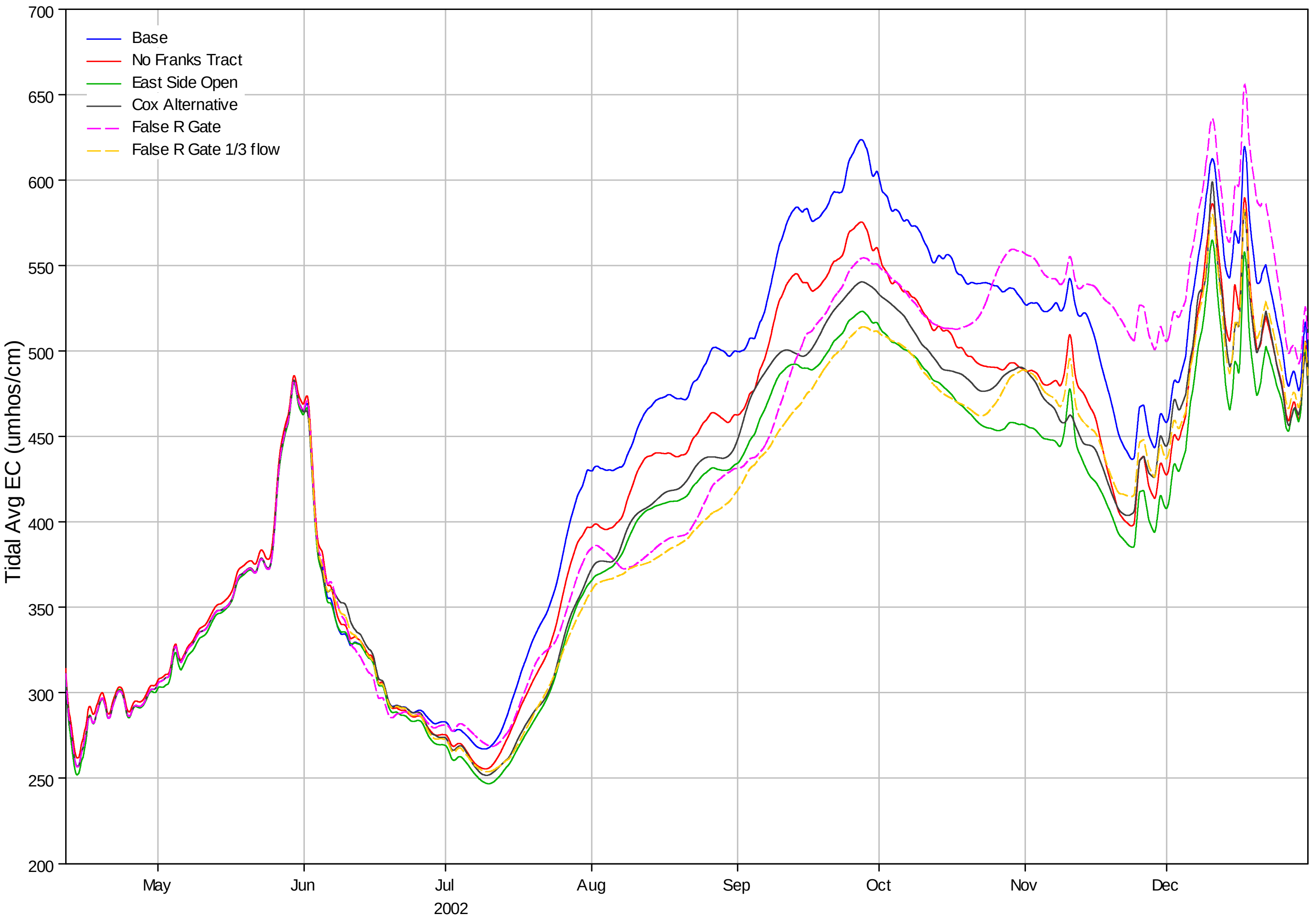

Figure 4-12 Tidally averaged EC results at the SWP intake.

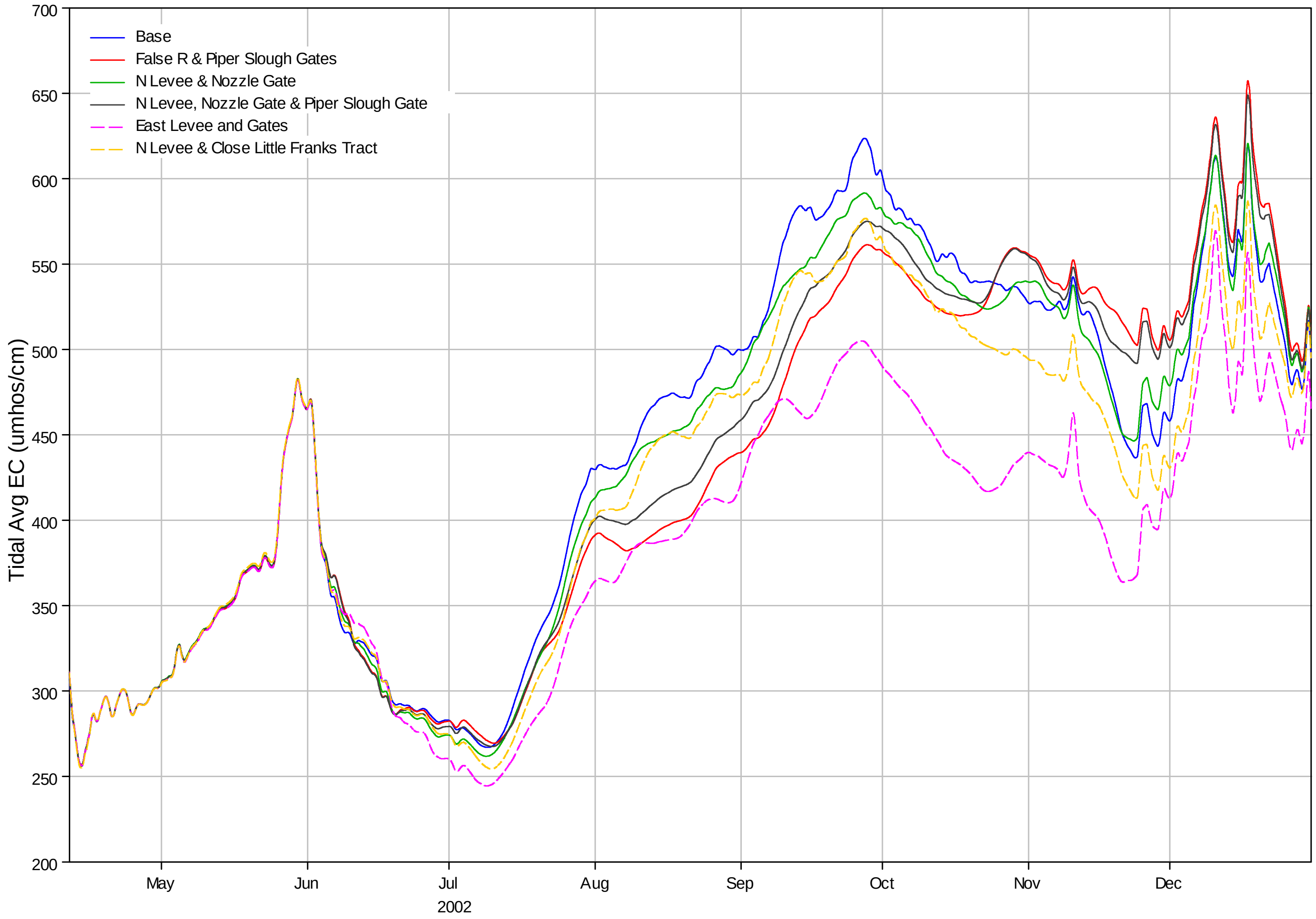

Figure 4-13 Tidally averaged EC results at the SWP intake.

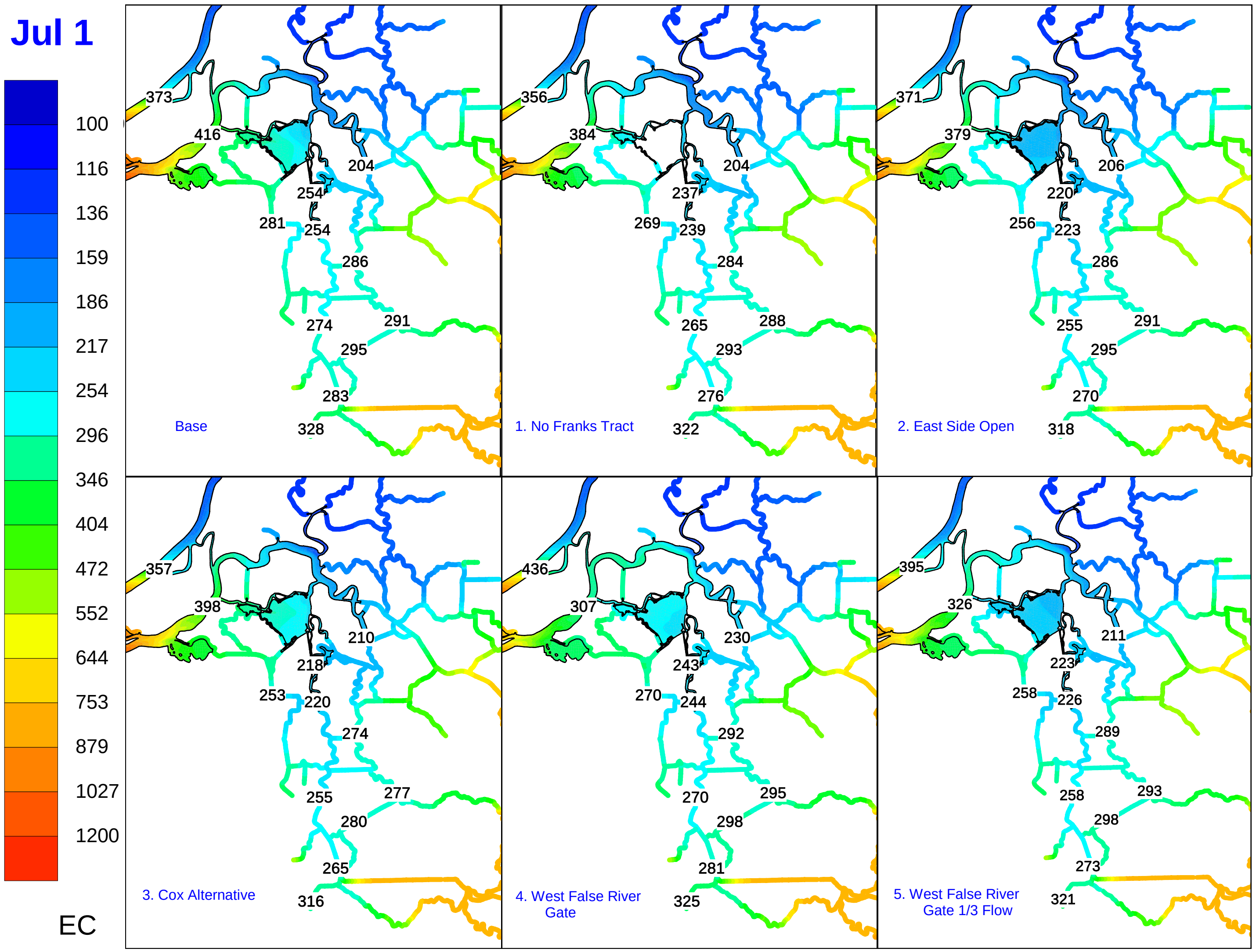

Figure 4-14 Tidally averaged EC contours on July 1, 2002.

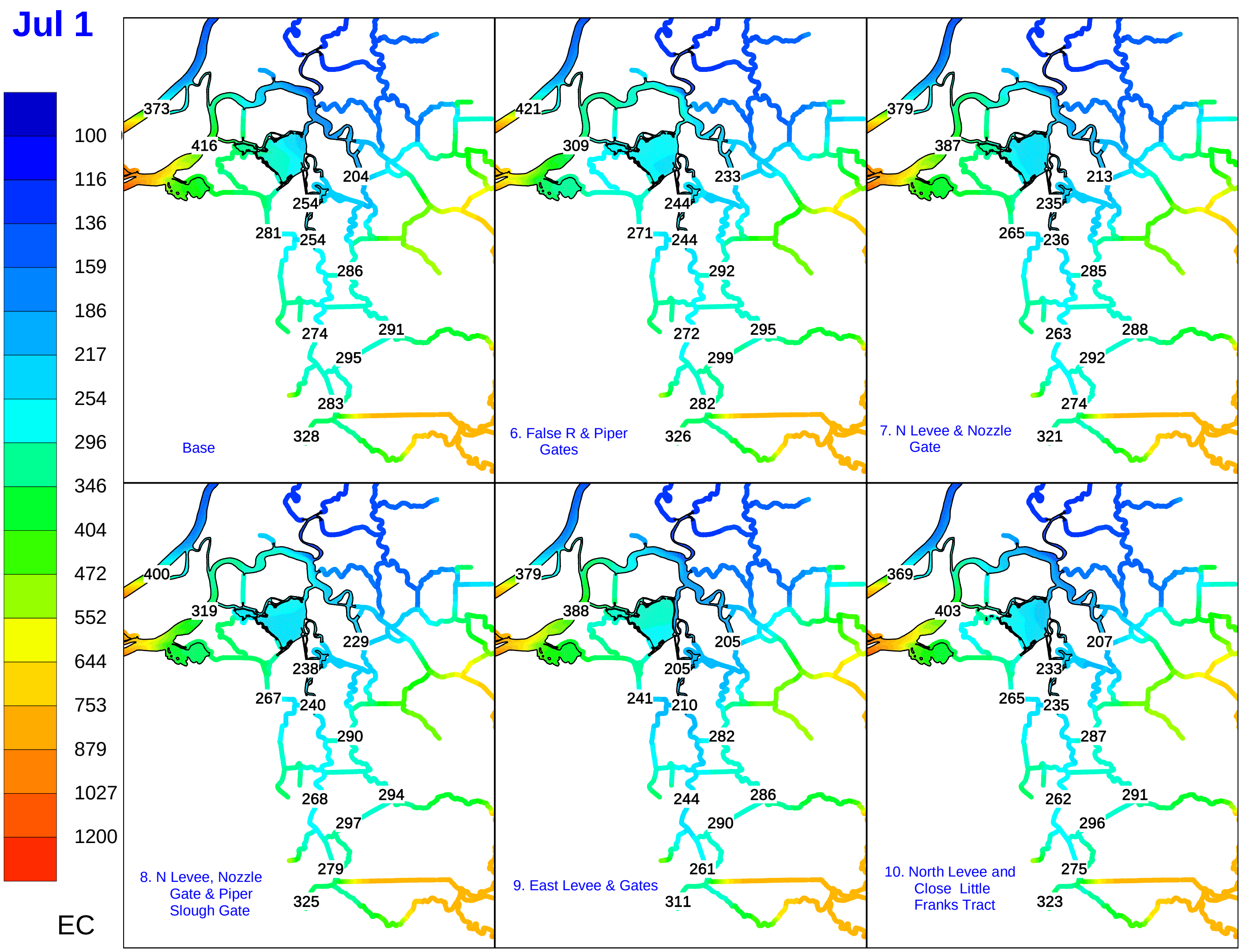

Figure 4-15 Tidally averaged EC contours on July 1, 2002.

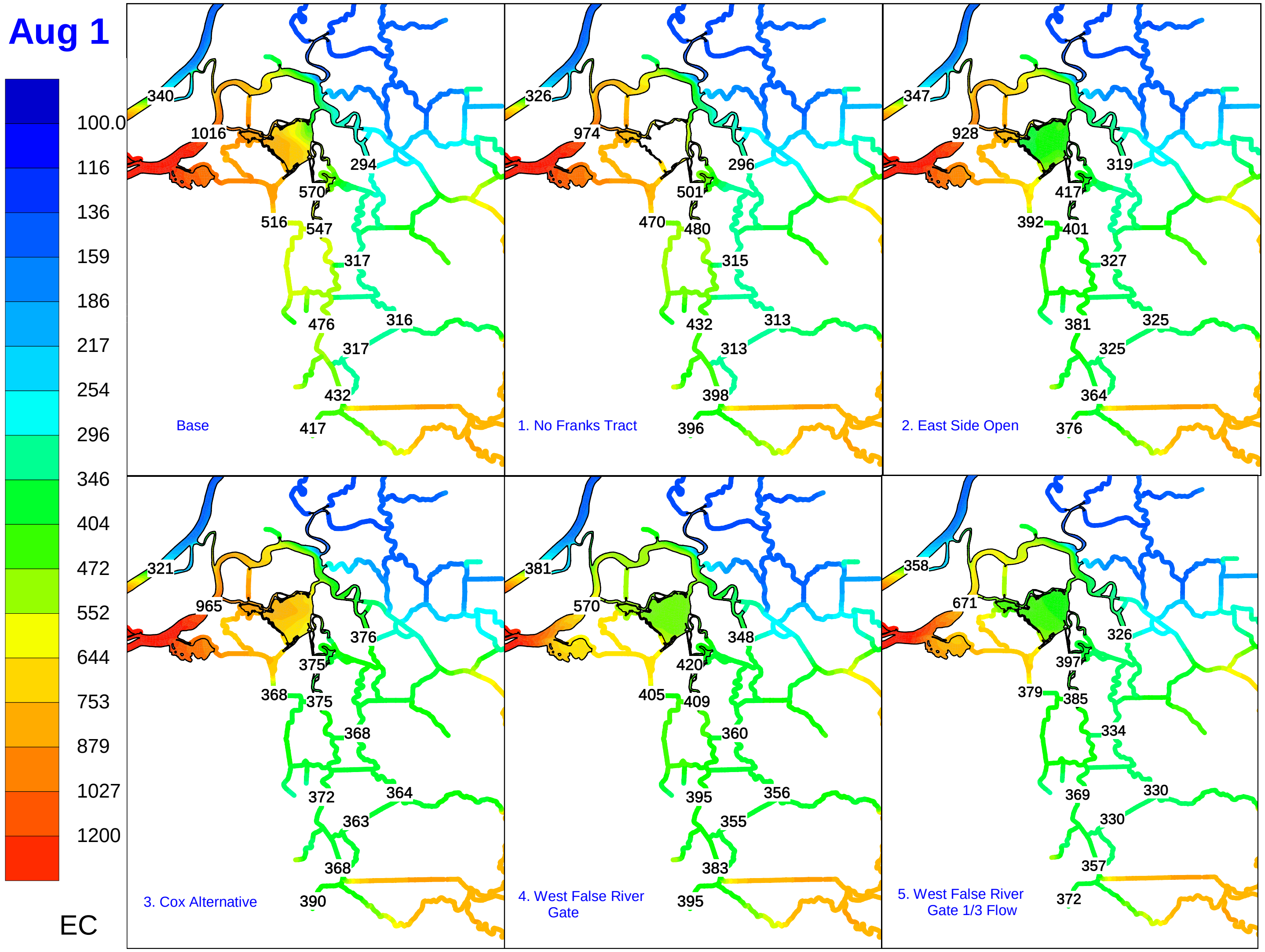

Figure 4-16 Tidally averaged EC contours on August 1, 2002.

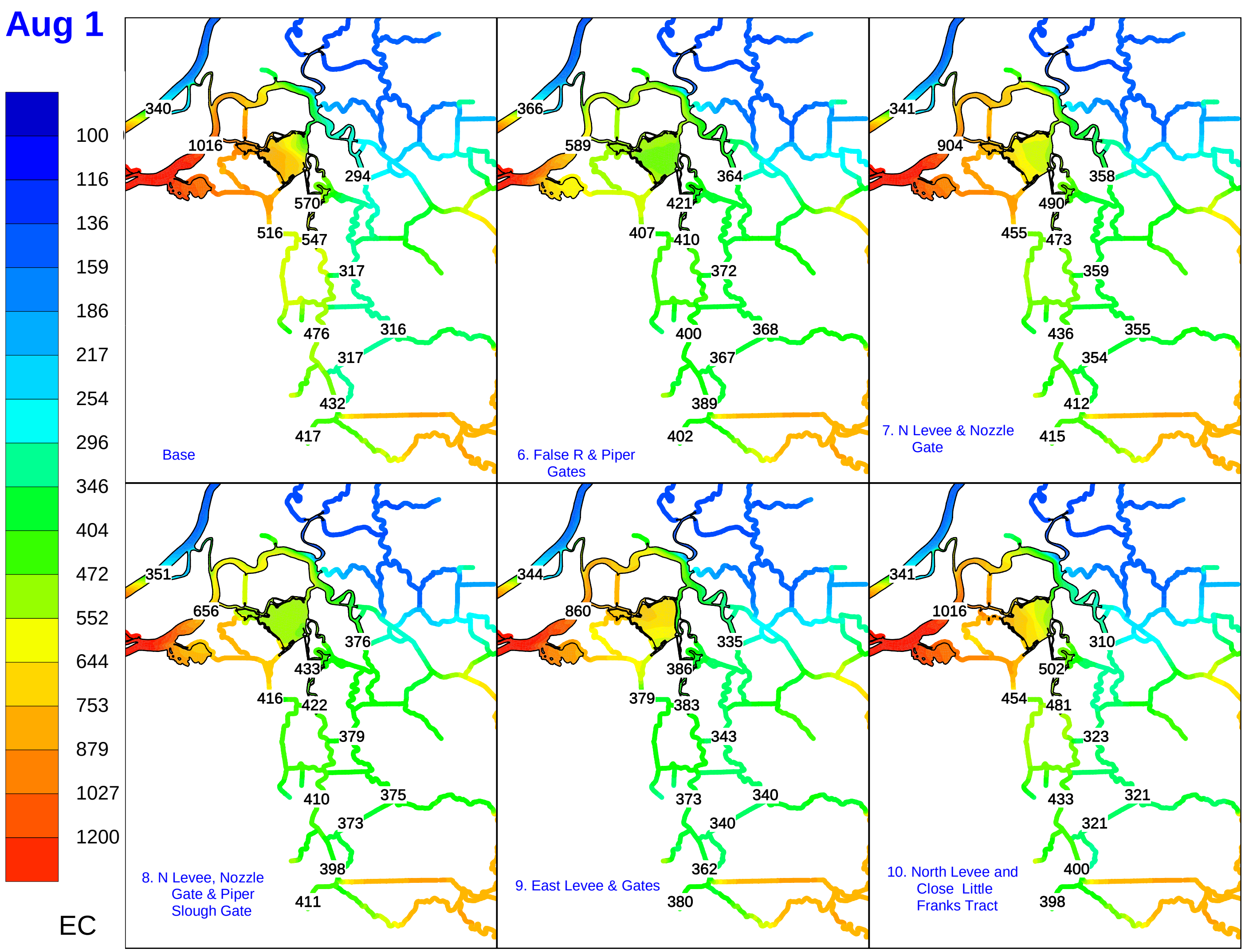

Figure 4-17 Tidally averaged EC contours on August 1, 2002.

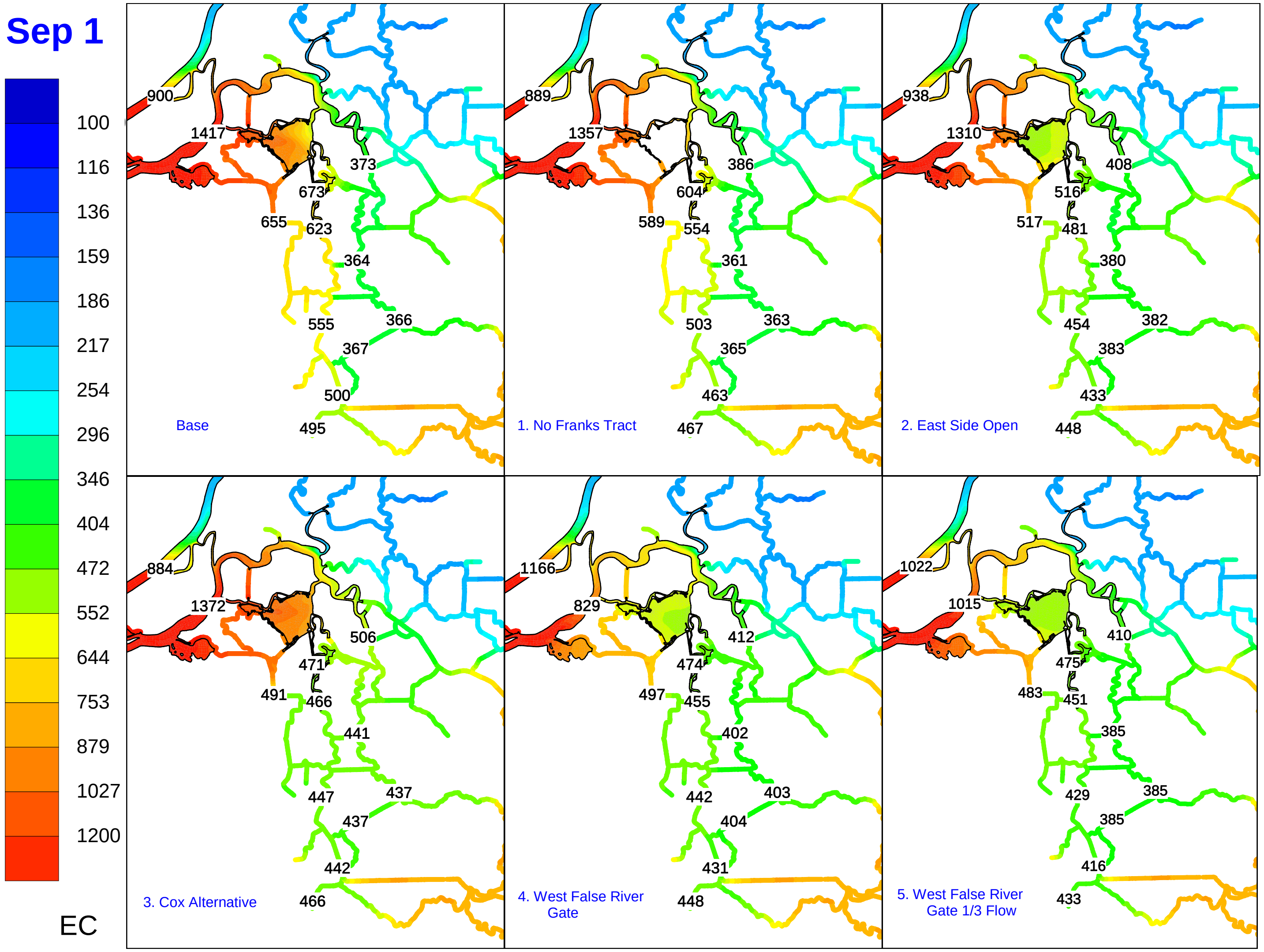

Figure 4-18 Tidally averaged EC contours on September 1, 2002.

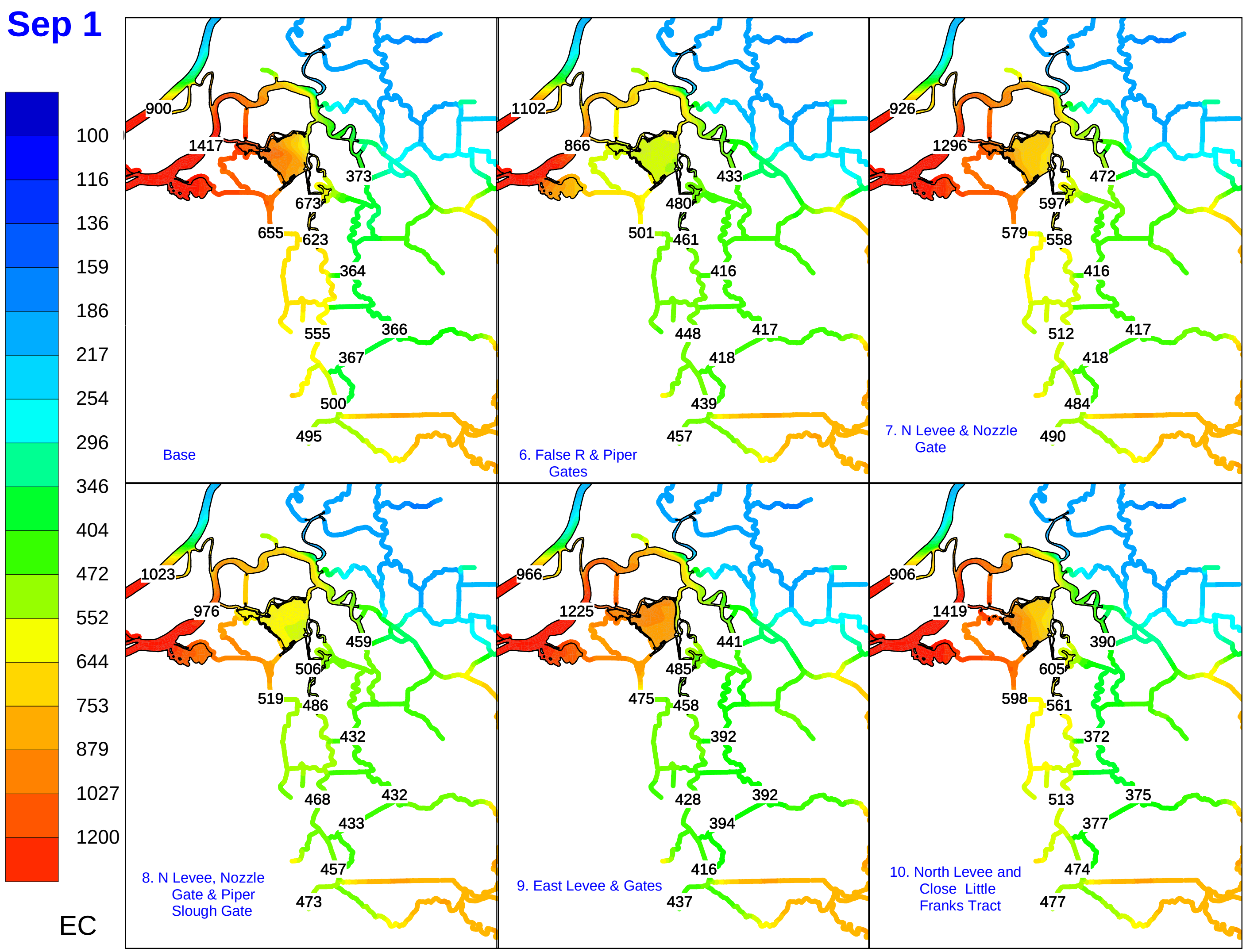

Figure 4-19 Tidally averaged EC contours on September 1, 2002.

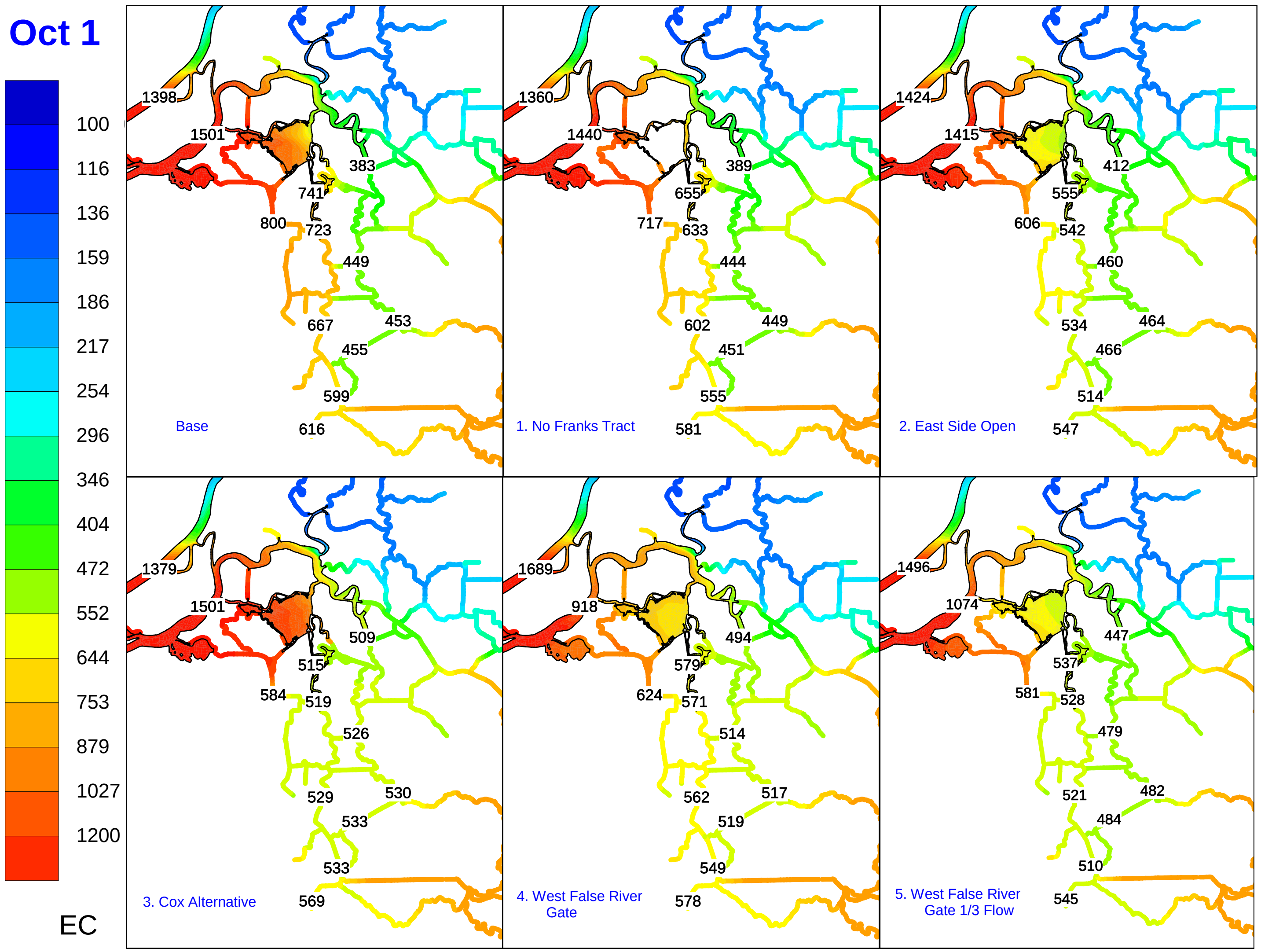

Figure 4-20 Tidally averaged EC contours on October 1, 2002.

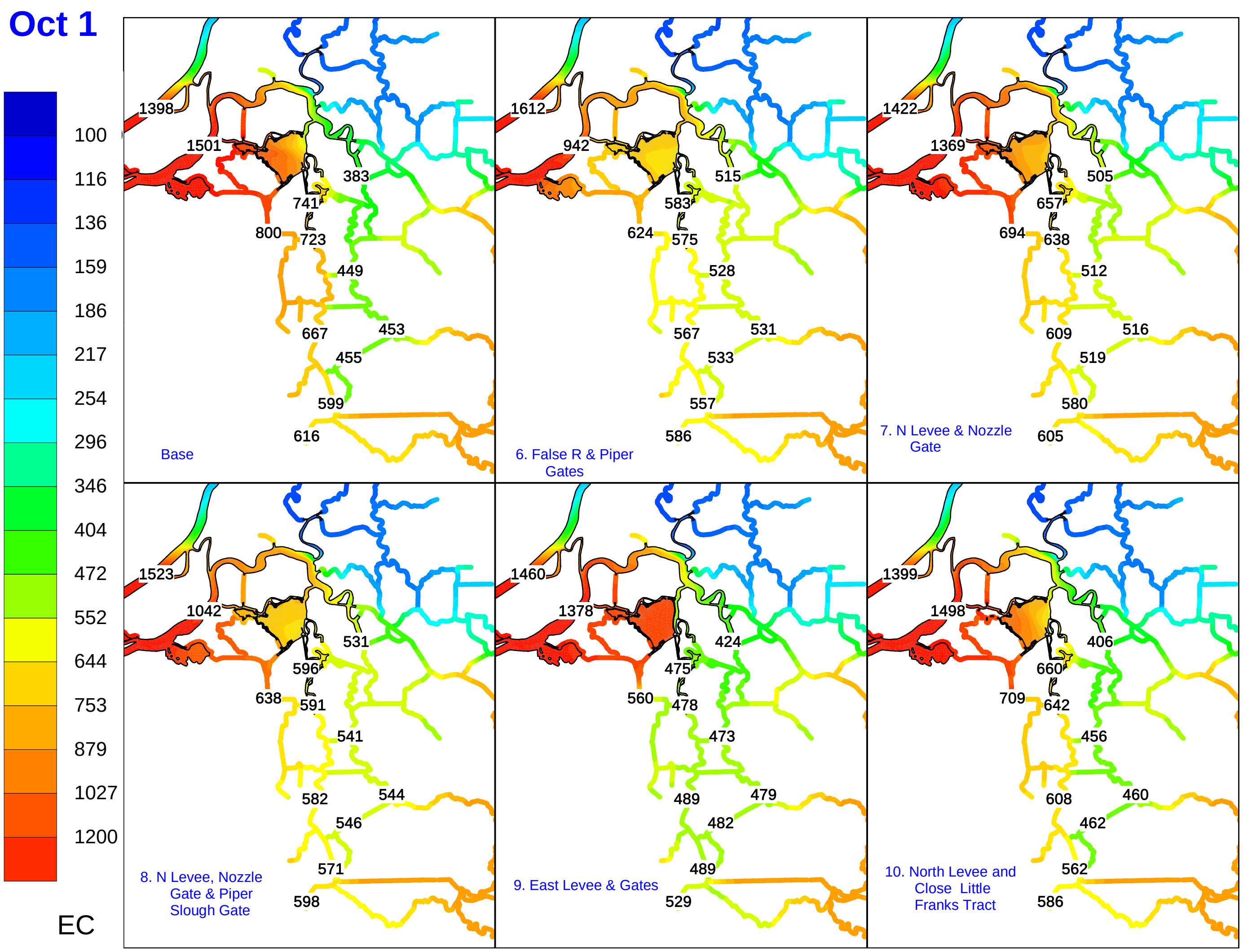

Figure 4-21 Tidally averaged EC contours on October 1, 2002.

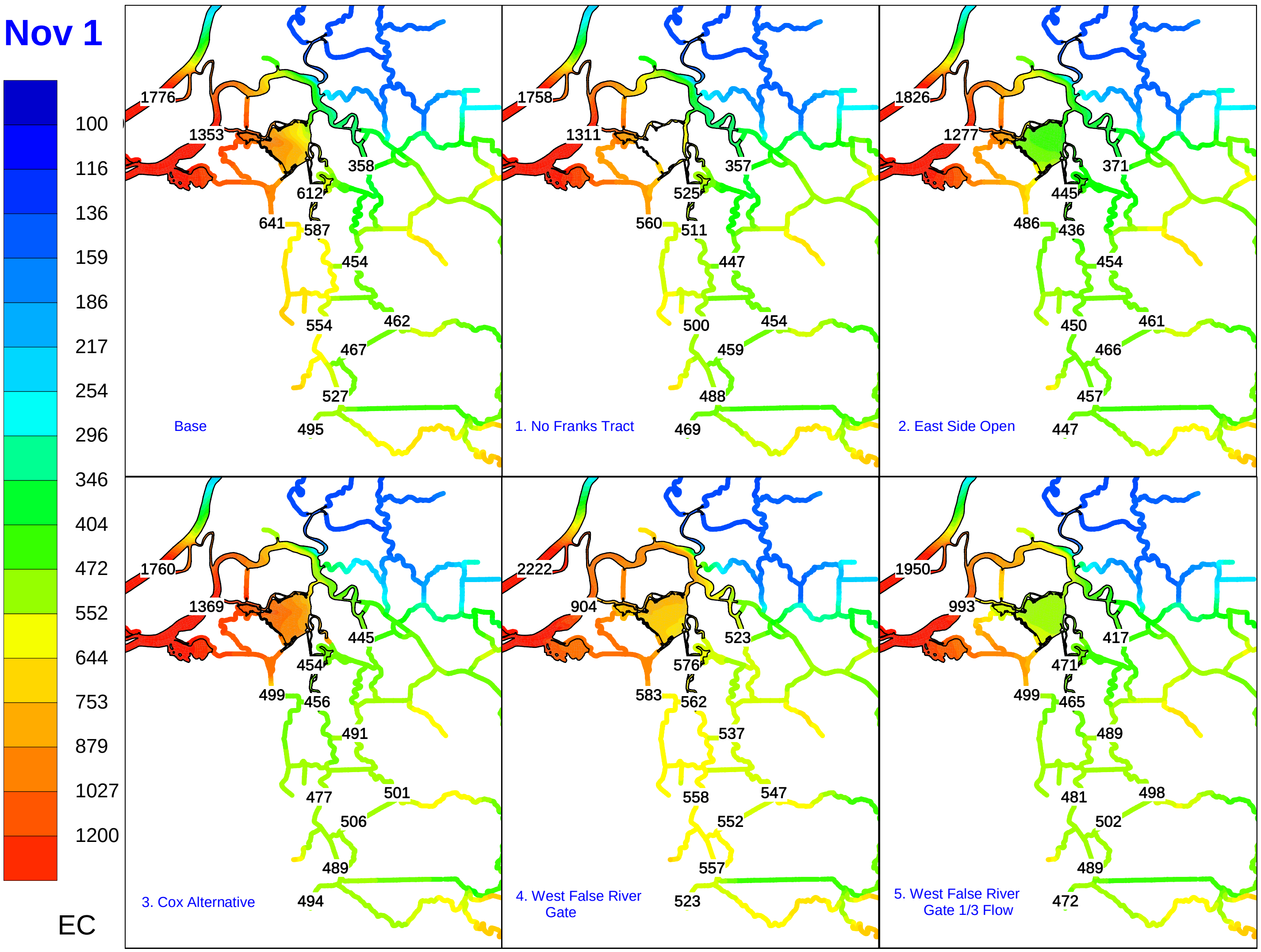

Figure 4-22 Tidally averaged EC contours on November 1, 2002.

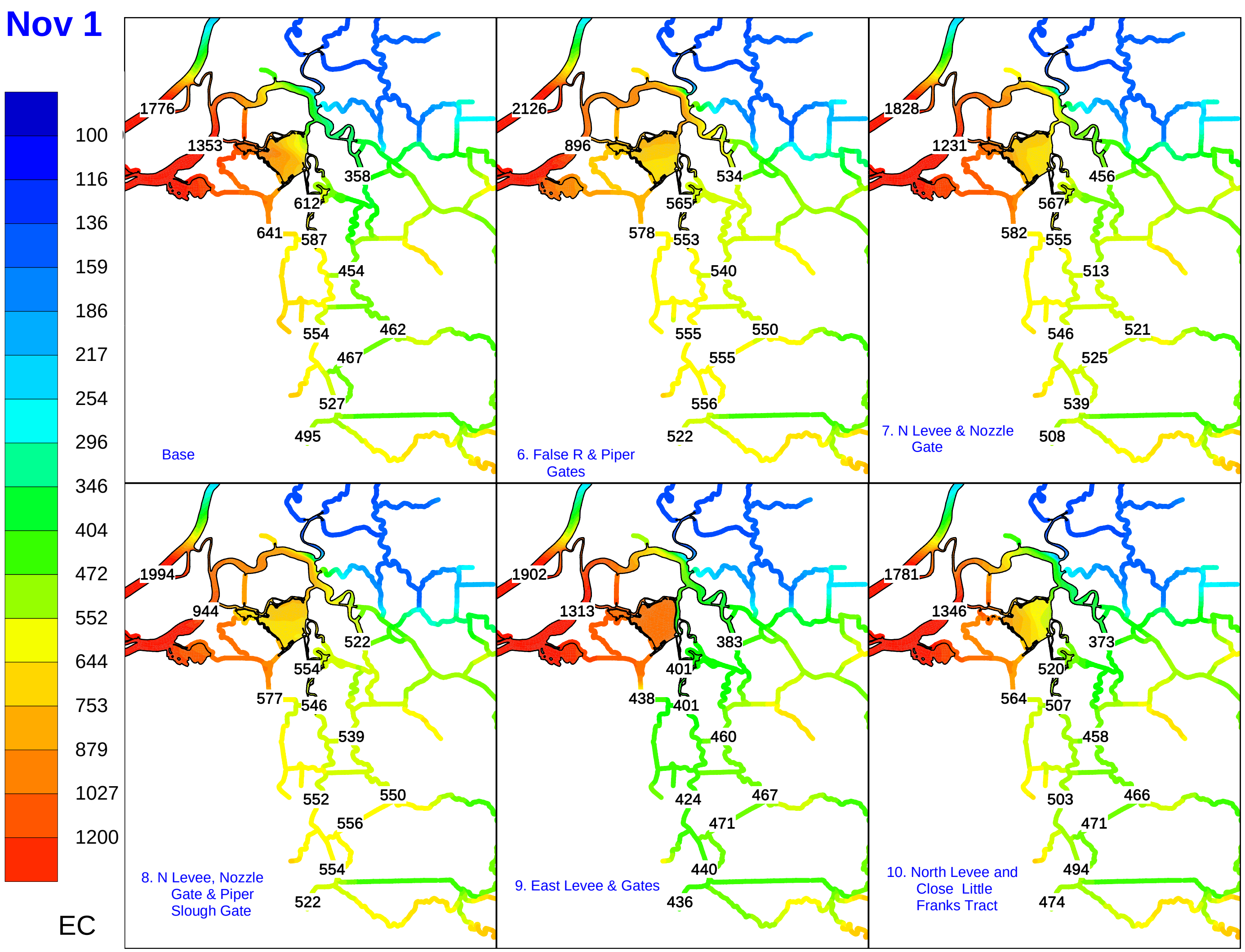

Figure 4-23 Tidally averaged EC contours on November 1, 2002.

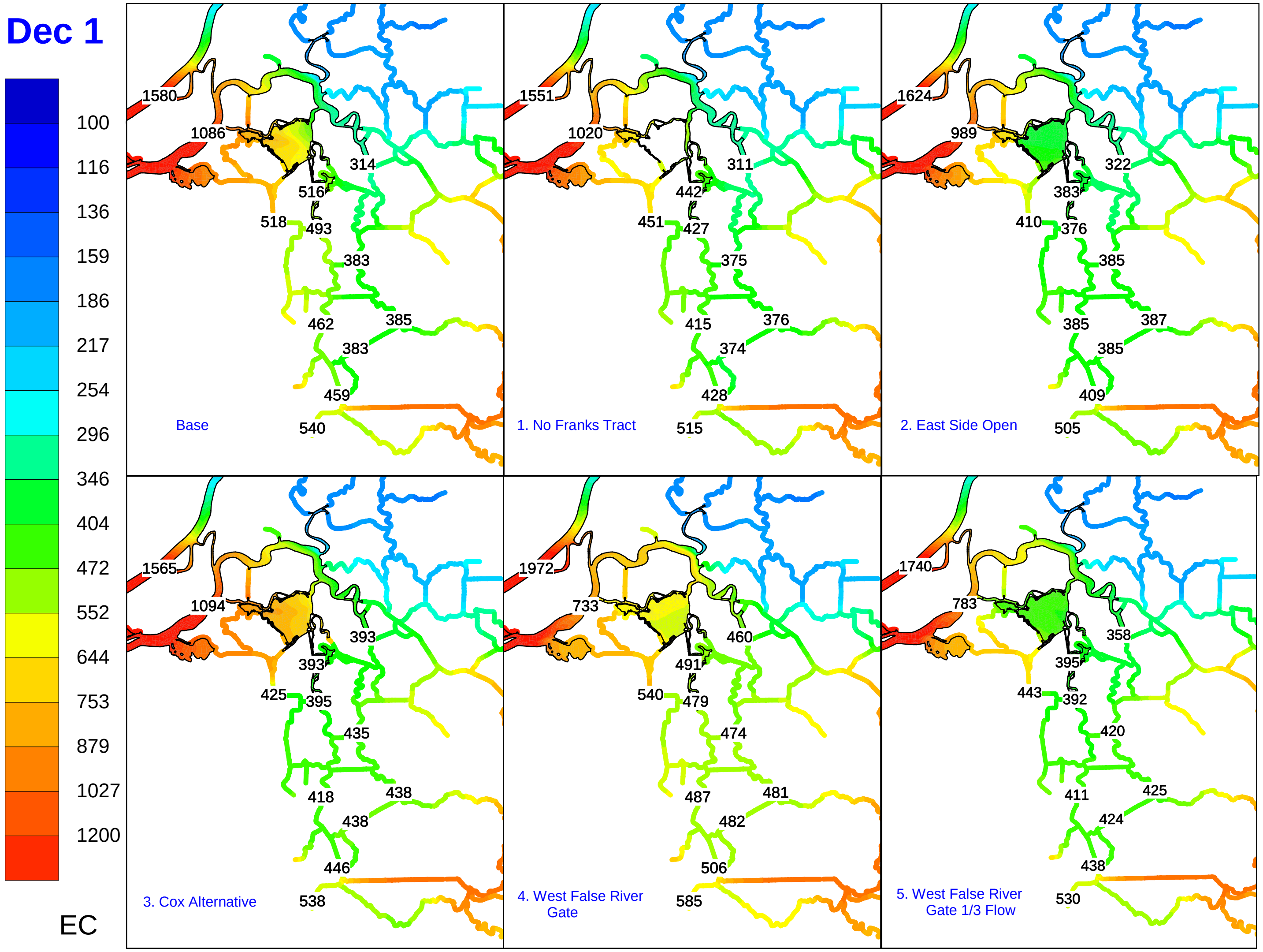

Figure 4-24 Tidally averaged EC contours on December 1, 2002.

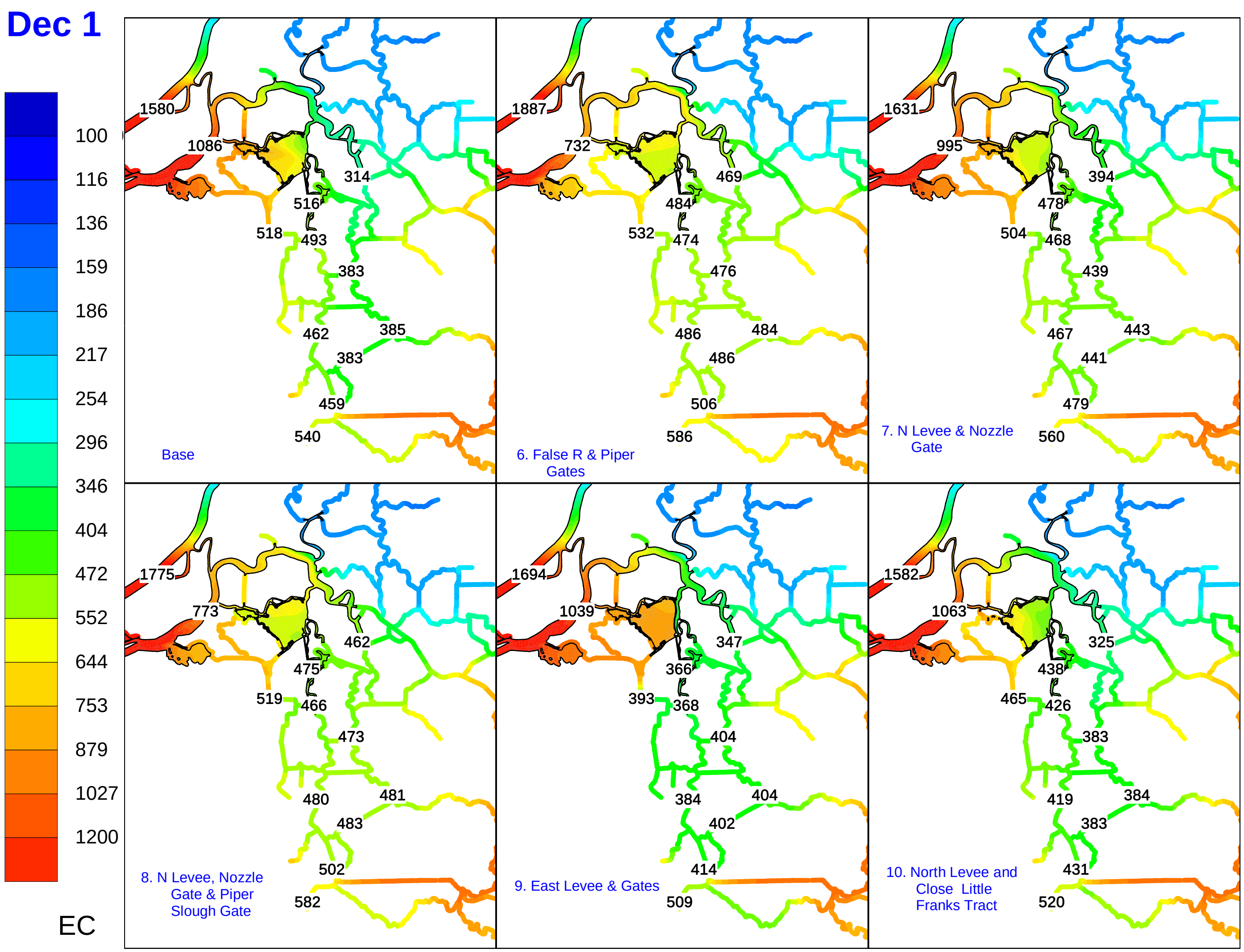

Figure 4-25 Tidally averaged EC contours on December 1, 2002.

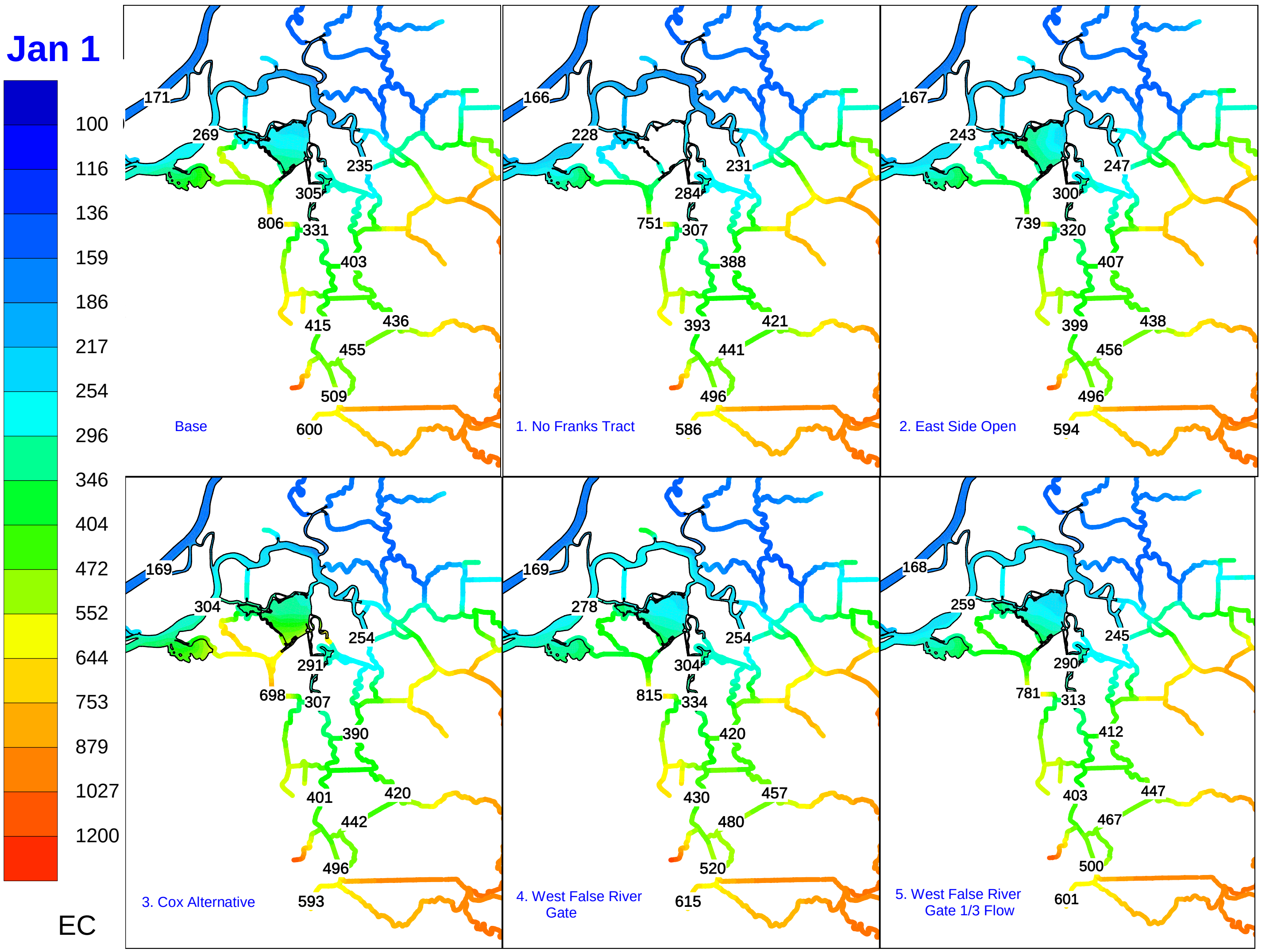

Figure 4-26 Tidally averaged EC contours on January 1, 2002.

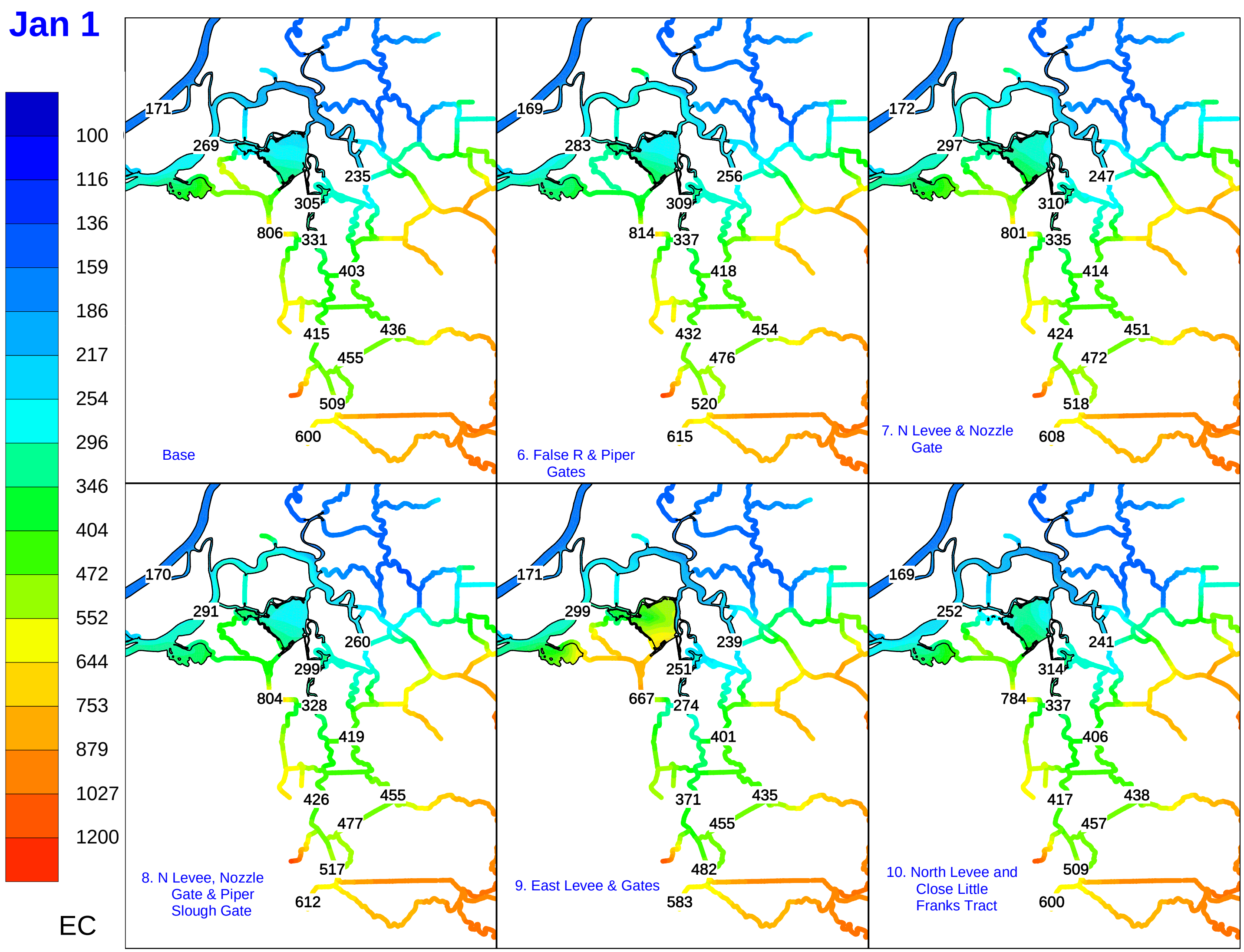

Figure 4-27 Tidally averaged EC contours on January 1, 2002.

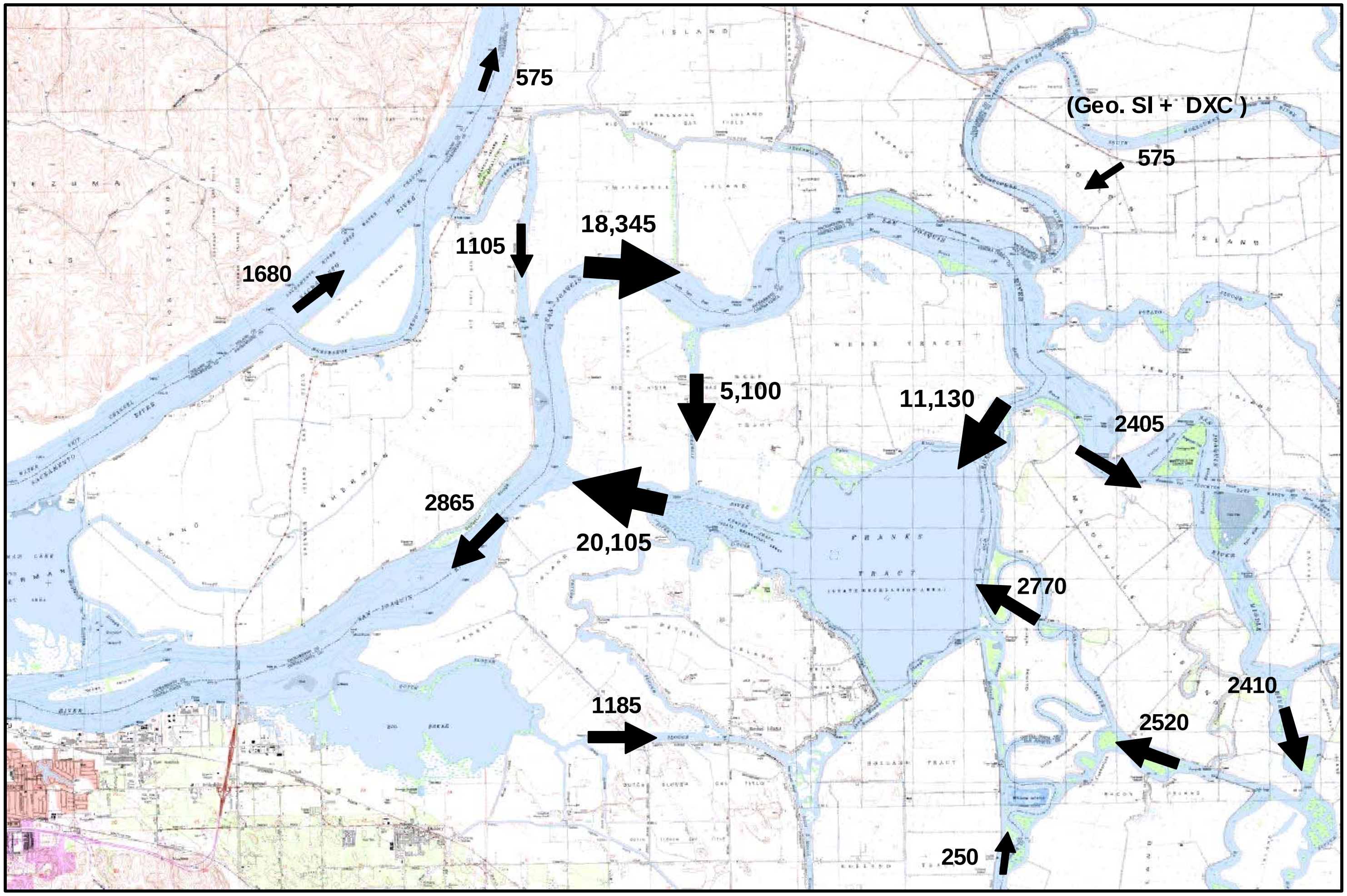

Figure 4-28 Change from Base case July 2002 average flows for the "West False River Gate" alternative.

Table 4-1 Peak tidally averaged EC and % reduction from Base for each alternative at key locations in May 2002.

	Peak Tidally Averaged EC (umhos/cm)											
	May 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	483		496		363		406		255		389	
No Franks Tract	486	-1	499	-1	373	-3	415	-2	247	3	385	1
East Side Open	481	0	498	0	366	-1	405	0	240	6	384	1
Cox Alternative	483	0	497	0	364	0	407	0	256	-1	390	0
W. False R. Gate	483	0	496	0	363	0	406	0	255	0	389	0
W. False R. Gate 1/3 Flow	483	0	496	0	363	0	406	0	255	0	389	0
False R. & Piper Sl. Gates	483	0	496	0	363	0	406	0	255	0	389	0
N. Levee & Nozzle Gate	483	0	497	0	365	-1	408	-1	254	0	389	0
N. Levee, Nozzle Gate & Piper Sl Gate	483	0	497	0	364	0	408	0	254	0	389	0
East Levee & Gates	482	0	496	0	363	0	405	0	254	0	389	0
N. Levee & Close Little Franks Tract	483	0	498	0	368	-2	411	-1	248	3	388	0

Table 4-2 Peak tidally averaged EC and % reduction from Base for each alternative at key locations in June 2002.

	Peak Tidally Averaged EC (umhos/cm)											
	June 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	469		491		362		357		485		389	
No Franks Tract	474	-1	494	-1	373	-3	371	-4	438	10	385	1
East Side Open	467	1	493	0	365	-1	359	-1	437	10	384	1
Cox Alternative	465	1	491	0	363	0	358	0	457	6	390	0
W. False R. Gate	471	0	492	0	363	0	357	0	340	30	389	0
W. False R. Gate 1/3 Flow	461	2	480	2	361	0	354	1	377	22	390	0
False R. & Piper Sl. Gates	471	0	492	0	363	0	357	0	346	29	390	0
N. Levee & Nozzle Gate	470	0	492	0	364	-1	359	-1	451	7	389	0
N. Levee, Nozzle Gate & Piper Sl Gate	471	0	492	0	364	0	358	0	364	25	390	0
East Levee & Gates	469	0	491	0	362	0	356	0	435	10	389	0
N. Levee & Close Little Franks Tract	470	0	493	0	368	-2	363	-2	470	3	389	0

Table 4-3 Peak tidally averaged EC and % reduction from Base for each alternative at key locations in July 2002.

	Peak Tidally Averaged EC (umhos/cm)											
	July 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	430		425		481		524		1182		319	
No Franks Tract	397	8	406	5	435	10	476	9	1112	6	316	1
East Side Open	366	15	383	10	384	20	397	24	1091	8	329	-3
Cox Alternative	372	13	394	7	376	22	373	29	1110	6	370	-16
W. False R. Gate	385	11	399	6	397	18	410	22	695	41	361	-13
W. False R. Gate 1/3 Flow	360	16	378	11	373	22	383	27	853	28	336	-5
False R. & Piper Sl. Gates	391	9	406	4	401	17	412	21	720	39	373	-17
N. Levee & Nozzle Gate	413	4	420	1	440	9	461	12	1080	9	360	-13
N. Levee, Nozzle Gate & Piper Sl Gate	400	7	414	3	411	15	422	19	802	32	381	-19
East Levee & Gates	364	15	386	9	375	22	383	27	992	16	344	-8
N. Levee & Close Little Franks Tract	401	7	404	5	438	9	460	12	1181	0	325	-2

Table 4-4 Peak tidally averaged EC and % reduction from Base for each alternative at key locations in August 2002.

	Peak Tidally Averaged EC (umhos/cm)											
	August 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	502		495		557		655		1475		371	
No Franks Tract	464	8	467	6	506	9	591	10	1409	4	368	1
East Side Open	434	13	449	9	458	18	518	21	1373	7	385	-4
Cox Alternative	448	11	471	5	456	18	493	25	1427	3	442	-19
W. False R. Gate	431	14	448	9	443	21	498	24	880	40	404	-9
W. False R. Gate 1/3 Flow	418	17	436	12	434	22	484	26	1075	27	386	-4
False R. & Piper Sl. Gates	440	12	457	8	449	19	502	23	919	38	419	-13
N. Levee & Nozzle Gate	486	3	493	0	519	7	580	12	1357	8	418	-13
N. Levee, Nozzle Gate & Piper Sl Gate	459	9	474	4	471	15	520	21	1032	30	433	-17
East Levee & Gates	422	16	442	11	439	21	478	27	1281	13	395	-6
N. Levee & Close Little Franks Tract	474	6	477	4	515	8	599	9	1478	0	379	-2

Table 4-5 Peak tidally averaged EC and % reduction from Base for each alternative at key locations in September 2002.

	Peak Tidally Averaged EC (umhos/cm)											
	September 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	624		623		698		800		1728		455	
No Franks Tract	575	8	584	6	629	10	717	10	1667	4	451	1
East Side Open	523	16	547	12	548	22	606	24	1622	6	466	-2
Cox Alternative	540	13	569	9	542	22	583	27	1693	2	537	-18
W. False R. Gate	554	11	578	7	570	18	624	22	1023	41	521	-14
W. False R. Gate 1/3 Flow	514	18	544	13	528	24	581	27	1244	28	485	-6
False R. & Piper Sl. Gates	561	10	585	6	573	18	624	22	1051	39	535	-18
N. Levee & Nozzle Gate	592	5	605	3	623	11	694	13	1575	9	521	-14
N. Levee, Nozzle Gate & Piper Sl Gate	575	8	598	4	588	16	638	20	1171	32	548	-20
East Levee & Gates	505	19	529	15	516	26	563	30	1535	11	484	-6
N. Levee & Close Little Franks Tract	577	8	588	6	627	10	709	11	1736	0	462	-2

Table 4-6 Peak tidally averaged EC and % reduction from Base for each alternative at key locations in October 2002.

	Peak Tidally Averaged EC (umhos/cm)											
	October 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	601		616		667		801		1599		468	
No Franks Tract	557	7	581	6	603	10	717	10	1512	5	460	2
East Side Open	515	14	548	11	534	20	606	24	1505	6	467	0
Cox Alternative	533	11	573	7	530	21	587	27	1604	0	532	-14
W. False R. Gate	560	7	581	6	562	16	625	22	1054	34	558	-19
W. False R. Gate 1/3 Flow	511	15	549	11	522	22	581	27	1197	25	504	-8
False R. & Piper Sl. Gates	560	7	589	4	567	15	625	22	1067	33	563	-20
N. Levee & Nozzle Gate	581	3	604	2	609	9	694	13	1474	8	526	-13
N. Levee, Nozzle Gate & Piper Sl Gate	571	5	601	2	582	13	639	20	1148	28	563	-20
East Levee & Gates	490	18	533	13	489	27	560	30	1502	6	481	-3
N. Levee & Close Little Franks Tract	563	6	586	5	608	9	710	11	1589	1	472	-1

Table 4-7 Peak tidally averaged EC and % reduction from Base for each alternative at key locations in November 2002.

	Peak Tidally Averaged EC (umhos/cm)											
	November 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	542		562		574		641		1911		464	
No Franks Tract	510	6	535	5	509	11	560	13	1783	7	457	2
East Side Open	478	12	526	6	450	22	486	24	1812	5	463	0
Cox Alternative	489	10	553	2	477	17	500	22	1897	1	503	-8
W. False R. Gate	557	-3	604	-7	558	3	597	7	1243	35	549	-18
W. False R. Gate 1/3 Flow	495	9	550	2	481	16	501	22	1452	24	500	-8
False R. & Piper Sl. Gates	556	-2	603	-7	555	3	587	8	1249	35	552	-19
N. Levee & Nozzle Gate	540	0	576	-3	546	5	583	9	1758	8	522	-13
N. Levee, Nozzle Gate & Piper Sl Gate	555	-2	599	-7	552	4	579	10	1338	30	552	-19
East Levee & Gates	463	15	524	7	424	26	440	31	1793	6	468	-1
N. Levee & Close Little Franks Tract	509	6	542	4	505	12	564	12	1907	0	468	-1

Table 4-8 Peak tidally averaged EC and % reduction from Base for each alternative at key locations in December 2002.

	Peak Tidally Averaged EC (umhos/cm)											
	December 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	620		697		570		863		1395		465	
No Franks Tract	590	5	676	3	515	10	806	7	1281	8	452	3
East Side Open	565	9	661	5	463	19	767	11	1295	7	455	2
Cox Alternative	599	3	678	3	484	15	740	14	1367	2	486	-4
W. False R. Gate	656	-6	731	-5	592	-4	857	1	950	32	563	-21
W. False R. Gate 1/3 Flow	583	6	682	2	494	13	801	7	1049	25	484	-4
False R. & Piper Sl. Gates	657	-6	731	-5	590	-4	854	1	953	32	566	-22
N. Levee & Nozzle Gate	621	0	703	-1	551	3	839	3	1288	8	509	-9
N. Levee, Nozzle Gate & Piper Sl Gate	649	-5	726	-4	579	-2	847	2	1009	28	558	-20
East Levee & Gates	569	8	658	6	449	21	712	18	1302	7	461	1
N. Levee & Close Little Franks Tract	587	5	678	3	512	10	816	5	1373	2	457	2

Table 4-9 Monthly average EC and % reduction from Base for each alternative at key locations in May 2002.

	Monthly Averaged EC (umhos/cm)											
	May 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	368		383		332		376		237		362	
No Franks Tract	372	-1	386	-1	341	-2	384	-2	233	2	358	1
East Side Open	366	1	382	0	333	0	374	1	227	4	356	2
Cox Alternative	368	0	383	0	333	0	377	0	239	-1	362	0
W. False R. Gate	368	0	383	0	332	0	376	0	237	0	362	0
W. False R. Gate 1/3 Flow	368	0	383	0	332	0	376	0	237	0	362	0
False R. & Piper Sl. Gates	368	0	383	0	332	0	376	0	237	0	362	0
N. Levee & Nozzle Gate	369	0	384	0	334	0	378	0	237	0	362	0
N. Levee, Nozzle Gate & Piper Sl Gate	369	0	383	0	334	0	377	0	238	0	362	0
East Levee & Gates	368	0	383	0	332	0	375	0	237	0	362	0
N. Levee & Close Little Franks Tract	369	0	384	0	336	-1	380	-1	232	2	361	0

Table 4-10 Monthly average EC and % reduction from Base for each alternative at key locations in June 2002.

	Monthly Averaged EC (umhos/cm)											
	June 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	325		376		295		300		345		332	
No Franks Tract	325	0	376	0	296	0	303	-1	318	8	329	1
East Side Open	321	1	374	1	291	1	295	2	315	9	331	0
Cox Alternative	326	-1	381	-1	303	-3	304	-1	332	4	325	2
W. False R. Gate	323	0	374	1	296	0	297	1	279	19	328	1
W. False R. Gate 1/3 Flow	325	0	376	0	295	0	298	1	296	14	334	-1
False R. & Piper Sl. Gates	324	0	375	0	297	-1	297	1	283	18	327	1
N. Levee & Nozzle Gate	322	1	374	1	293	1	296	1	331	4	328	1
N. Levee, Nozzle Gate & Piper Sl Gate	323	0	375	0	295	0	295	1	292	15	327	1
East Levee & Gates	322	1	373	1	291	1	294	2	323	6	330	1
N. Levee & Close Little Franks Tract	324	0	376	0	294	0	299	0	334	3	333	0

Table 4-11 Monthly average EC and % reduction from Base for each alternative at key locations in July 2002.

	Monthly Averaged EC (umhos/cm)											
	July 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	323		341		345		356		864		277	
No Franks Tract	305	6	328	4	319	7	325	9	808	6	275	1
East Side Open	285	12	316	8	287	17	283	20	789	9	282	-2
Cox Alternative	290	10	324	5	286	17	277	22	811	6	300	-8
W. False R. Gate	307	5	333	2	309	10	307	14	517	40	303	-9
W. False R. Gate 1/3 Flow	288	11	318	7	287	17	284	20	614	29	288	-4
False R. & Piper Sl. Gates	310	4	337	1	311	10	308	13	533	38	308	-11
N. Levee & Nozzle Gate	313	3	337	1	321	7	321	10	785	9	296	-7
N. Levee, Nozzle Gate & Piper Sl Gate	311	4	338	1	313	9	309	13	587	32	309	-12
East Levee & Gates	285	12	317	7	283	18	275	23	732	15	290	-5
N. Levee & Close Little Franks Tract	303	6	327	4	314	9	316	11	859	1	279	-1

Table 4-12 Monthly average EC and % reduction from Base for each alternative at key locations in August 2002.

	Monthly Averaged EC (umhos/cm)											
	August 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	467		466		520		605		1191		346	
No Franks Tract	434	7	444	5	474	9	550	9	1133	5	344	1
East Side Open	406	13	427	8	426	18	479	21	1098	8	361	-4
Cox Alternative	413	12	445	5	415	20	454	25	1146	4	409	-18
W. False R. Gate	394	16	420	10	405	22	460	24	688	42	370	-7
W. False R. Gate 1/3 Flow	385	18	411	12	397	24	450	26	835	30	358	-3
False R. & Piper Sl. Gates	403	14	429	8	412	21	464	23	714	40	383	-11
N. Levee & Nozzle Gate	450	4	464	1	477	8	540	11	1083	9	390	-13
N. Levee, Nozzle Gate & Piper Sl Gate	420	10	444	5	430	17	481	21	805	32	397	-15
East Levee & Gates	391	16	419	10	400	23	445	26	1021	14	371	-7
N. Levee & Close Little Franks Tract	442	5	450	3	481	8	551	9	1190	0	353	-2

Table 4-13 Monthly average EC and % reduction from Base for each alternative at key locations in September 2002.

	Monthly Averaged EC (umhos/cm)											
	September 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	571		568		641		726		1556		424	
No Franks Tract	533	7	540	5	586	9	657	9	1508	3	422	0
East Side Open	490	14	509	10	516	20	562	22	1460	6	436	-3
Cox Alternative	507	11	533	6	510	21	543	25	1536	1	503	-19
W. False R. Gate	500	13	520	8	517	19	553	24	917	41	469	-11
W. False R. Gate 1/3 Flow	474	17	498	12	490	24	529	27	1101	29	444	-5
False R. & Piper Sl. Gates	508	11	529	7	522	19	556	23	940	40	484	-14
N. Levee & Nozzle Gate	551	4	561	1	585	9	639	12	1406	10	483	-14
N. Levee, Nozzle Gate & Piper Sl Gate	526	8	545	4	541	16	575	21	1045	33	499	-18
East Levee & Gates	474	17	500	12	485	24	524	28	1398	10	452	-7
N. Levee & Close Little Franks Tract	535	6	541	5	584	9	652	10	1560	0	430	-2

Table 4-14 Monthly average EC and % reduction from Base for each alternative at key locations in October 2002.

	Monthly Averaged EC (umhos/cm)											
	October 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	555		557		595		706		1325		457	
No Franks Tract	511	8	522	6	535	10	624	12	1269	4	448	2
East Side Open	477	14	496	11	480	19	541	23	1237	7	459	-1
Cox Alternative	497	10	515	7	488	18	528	25	1347	-2	508	-11
W. False R. Gate	532	4	544	2	535	10	579	18	850	36	523	-14
W. False R. Gate 1/3 Flow	483	13	503	10	479	19	528	25	954	28	483	-6
False R. & Piper Sl. Gates	537	3	550	1	538	10	580	18	854	36	532	-17
N. Levee & Nozzle Gate	546	2	556	0	557	6	627	11	1206	9	513	-12
N. Levee, Nozzle Gate & Piper Sl Gate	545	2	558	0	545	8	589	17	919	31	540	-18
East Levee & Gates	444	20	471	15	432	27	478	32	1263	5	461	-1
N. Levee & Close Little Franks Tract	520	6	530	5	542	9	631	11	1312	1	461	-1

Table 4-15 Monthly average EC and % reduction from Base for each alternative at key locations in November 2002.

	Monthly Averaged EC (umhos/cm)											
	November 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	493		515		512		597		1160		416	
No Franks Tract	452	8	484	6	455	11	516	14	1081	7	407	2
East Side Open	425	14	466	10	413	19	449	25	1065	8	416	0
Cox Alternative	444	10	476	7	429	16	459	23	1185	-2	452	-9
W. False R. Gate	531	-8	553	-8	530	-3	576	3	834	28	506	-22
W. False R. Gate 1/3 Flow	452	8	489	5	440	14	475	20	865	25	446	-7
False R. & Piper Sl. Gates	528	-7	552	-7	524	-2	567	5	826	29	509	-22
N. Levee & Nozzle Gate	495	-1	522	-1	496	3	550	8	1082	7	462	-11
N. Levee, Nozzle Gate & Piper Sl Gate	520	-6	545	-6	514	0	556	7	866	25	504	-21
East Levee & Gates	408	17	453	12	386	25	410	31	1120	3	420	-1
N. Levee & Close Little Franks Tract	460	7	491	5	462	10	521	13	1128	3	418	-1

Table 4-16 Monthly average EC and % reduction from Base for each alternative at key locations in December 2002.

	Monthly Averaged EC (umhos/cm)											
	December 2002											
	SWP		CVP		CCWD Old Riv		CCWD Rock S.		Jersey Pt		RMID023	
Alternative	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.	value	%reduc.
Base	533		595		503		790		801		439	
No Franks Tract	504	5	572	4	457	9	730	8	720	10	426	3
East Side Open	484	9	561	6	427	15	695	12	731	9	431	2
Cox Alternative	504	5	577	3	444	12	674	15	815	-2	461	-5
W. False R. Gate	561	-5	623	-5	515	-3	792	0	615	23	512	-17
W. False R. Gate 1/3 Flow	504	6	578	3	446	11	732	7	617	23	459	-5
False R. & Piper Sl. Gates	561	-5	622	-5	514	-2	789	0	613	23	513	-17
N. Levee & Nozzle Gate	540	-1	604	-1	494	2	772	2	763	5	478	-9
N. Levee, Nozzle Gate & Piper Sl Gate	556	-4	619	-4	506	-1	780	1	639	20	510	-16
East Levee & Gates	480	10	558	6	412	18	645	18	782	2	442	-1
N. Levee & Close Little Franks Tract	508	5	577	3	463	8	745	6	769	4	435	1

5 RESIDENCE TIME

Residence time is a measure of how quickly water is exchanged in a given region. Long residence times may be associated with higher water temperatures and increased biological activity. In a simple stirred tank with constant inflow and outflow, residence time is easily calculated as the volume of the tank divided by the flow rate. In a complex region like Franks Tract, measuring the residence time is not as simple. Tidal flows drive water in and out of many opening around Franks Tract periphery, and some of the water that moved out of Franks Tract on ebb tide may return on the flood tide. Also, because Franks Track is very large, it is not completely mixed and the residence time will vary from one area to another.

The numerical model was used to evaluate the residence time in by applying a continuous tracer load at a rate of 1 gram/m3 per day only to the water in Franks Tract. The tracer simulations were run for the summer period of 2002. If there was no exchange with the surrounding channels, the tracer concentration in Franks Tract would increase by 1 gram/m3 each day of the simulation. However, because water from other areas of the Delta move through Franks Tract, the concentration of tracer rises toward a dynamic equilibrium which varies spatially across Franks Tract and over time with the spring-neap tidal cycle and changes in Delta inflows and exports. The equilibrium value of tracer concentration is a direct measure of residence time in Franks Tract. In the surrounding Delta channels the tracer concentration provides an indication of the region influence by Franks Tract, and the tracer concentration can be interpreted as the average time that water at any channel location had previously been in Franks Tract.

Contour plots of tidally-averaged residence time are presented in Figures 5-1 through 5-10 for the Base Condition and each alternative, excluding the “No Franks Tract” alternative. The tracer loading was initiated July 1, 2002. The plots are shown for September 1, and represent the tracer concentrations after 62 days of simulation.

Note that the minimum “residence time” contour shown is 1 day. If lower contour values are shown, the spatial extent increases somewhat.

Maximum Base case residence times on September 1 in Franks Tract are approximately 4 days. Residence times are not significantly changed for several of the alternatives ("West False River Gate", "False River and Piper Slough Gates", and "North Levee and Nozzle Gate"). For the "North Levee, Nozzle Gate and Piper Slough Gate" alternative, the maximum residence time on September 1 is slightly lower at approximately 3 days. Maximum September 1 residence times were increased for the remaining alternatives. "East Side Open" was increased to 12 days, "Cox Alternative" was increased by 7 days, "East Levee and Gates" was increased to 15 days, and "West False River Gate 1/3 Flow" was increased to 6 days.

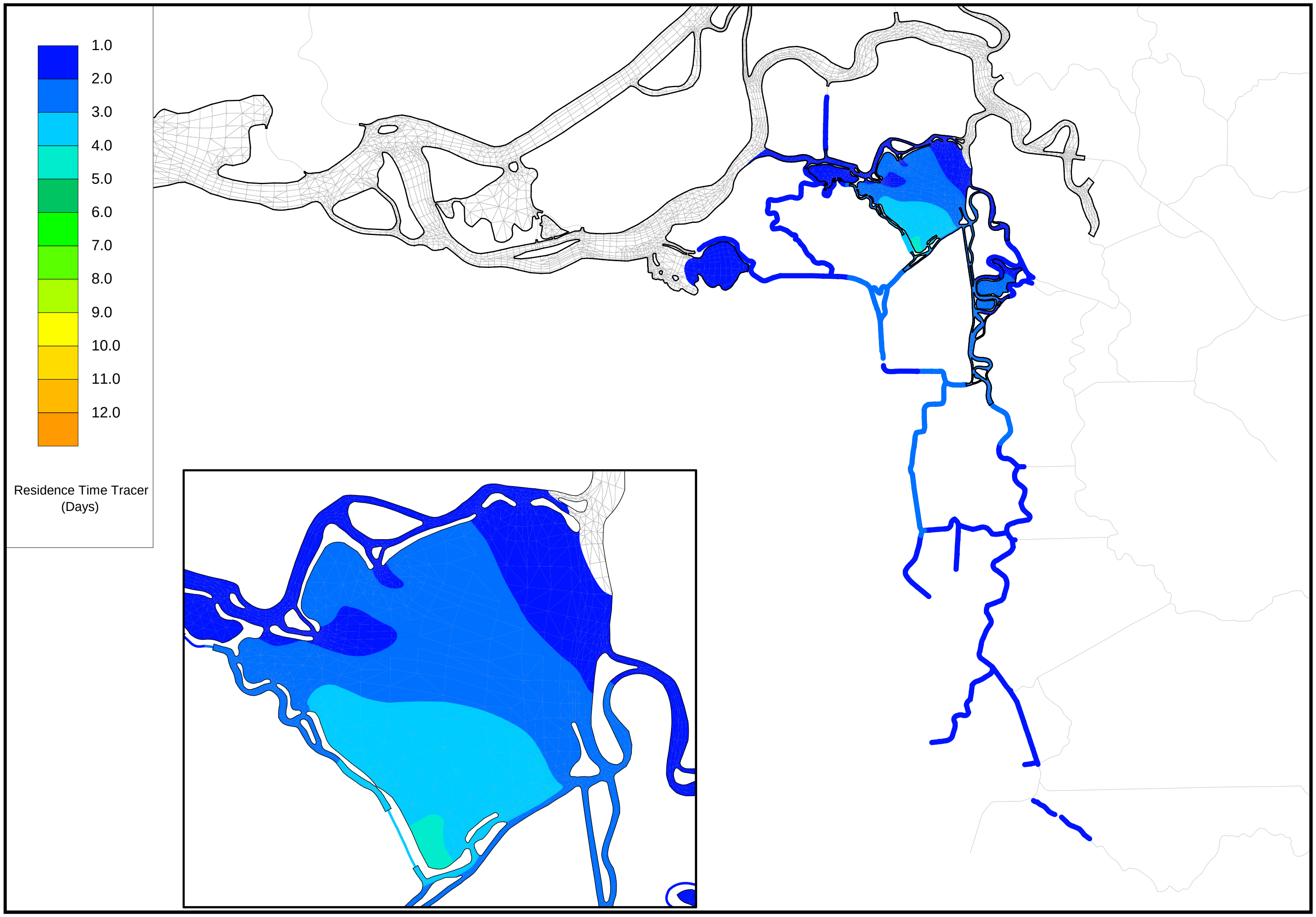

Figure 5-1 Contour plot of residence time for Base case on September 1 after 62 days of simulation.

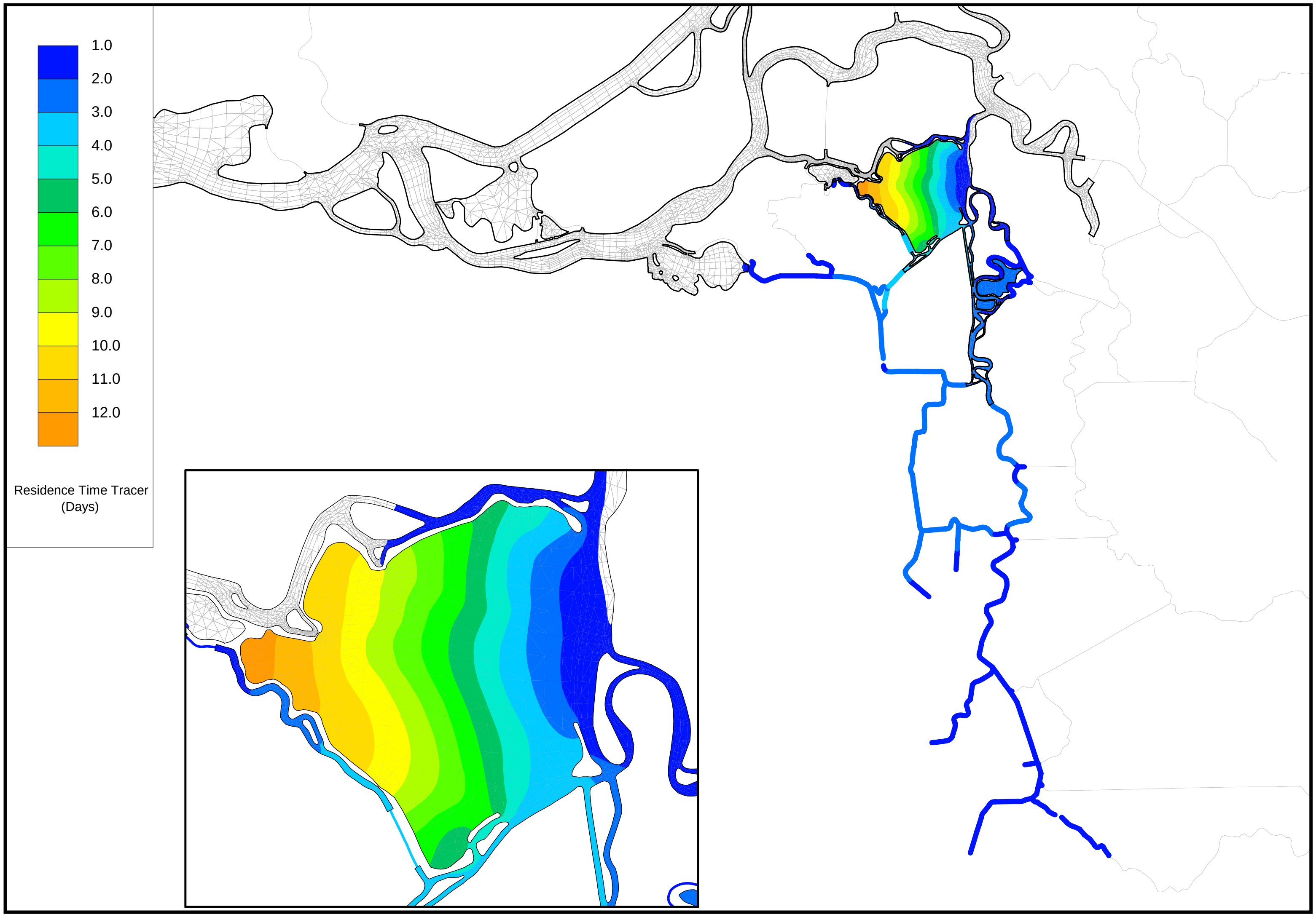

Figure 5-2 Contour plot of residence time for "East Side Open" alternative on September 1 after 62 days of simulation.

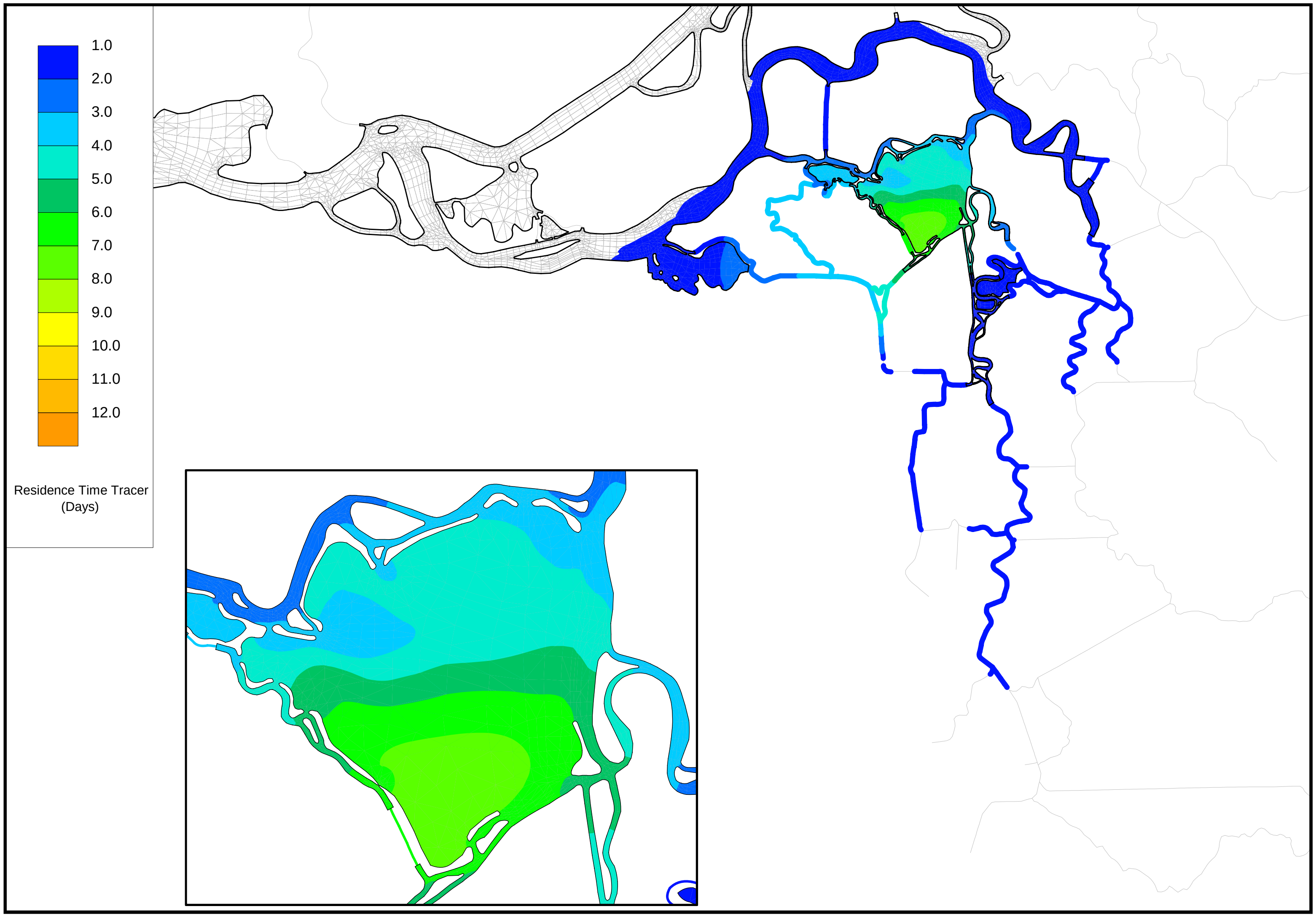

Figure 5-3 Contour plot of residence time for "Cox Alternative" on September 1 after 62 days of simulation.

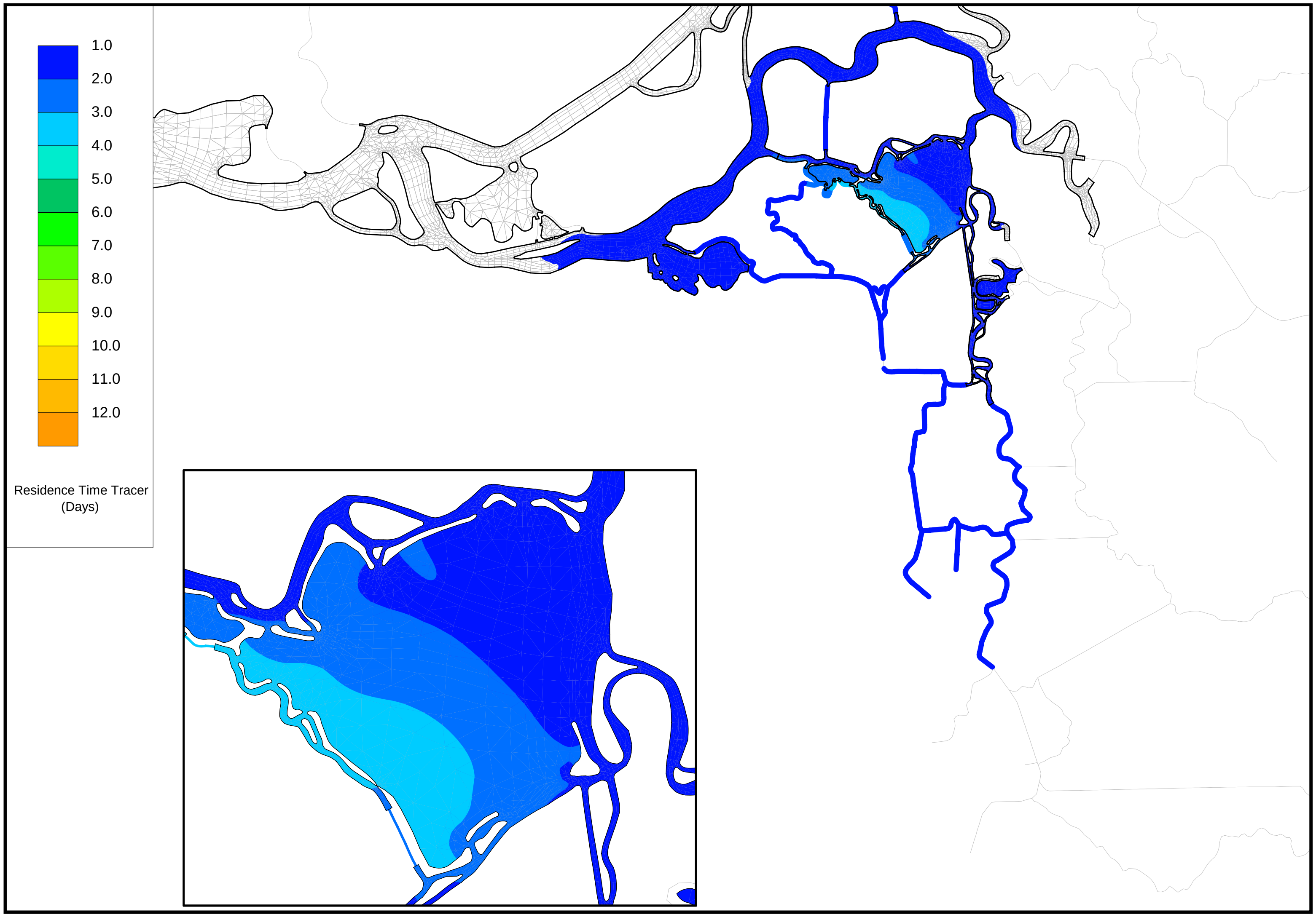

Figure 5-4 Contour plot of residence time for "West False River Gate" alternative on September 1 after 62 days of simulation.

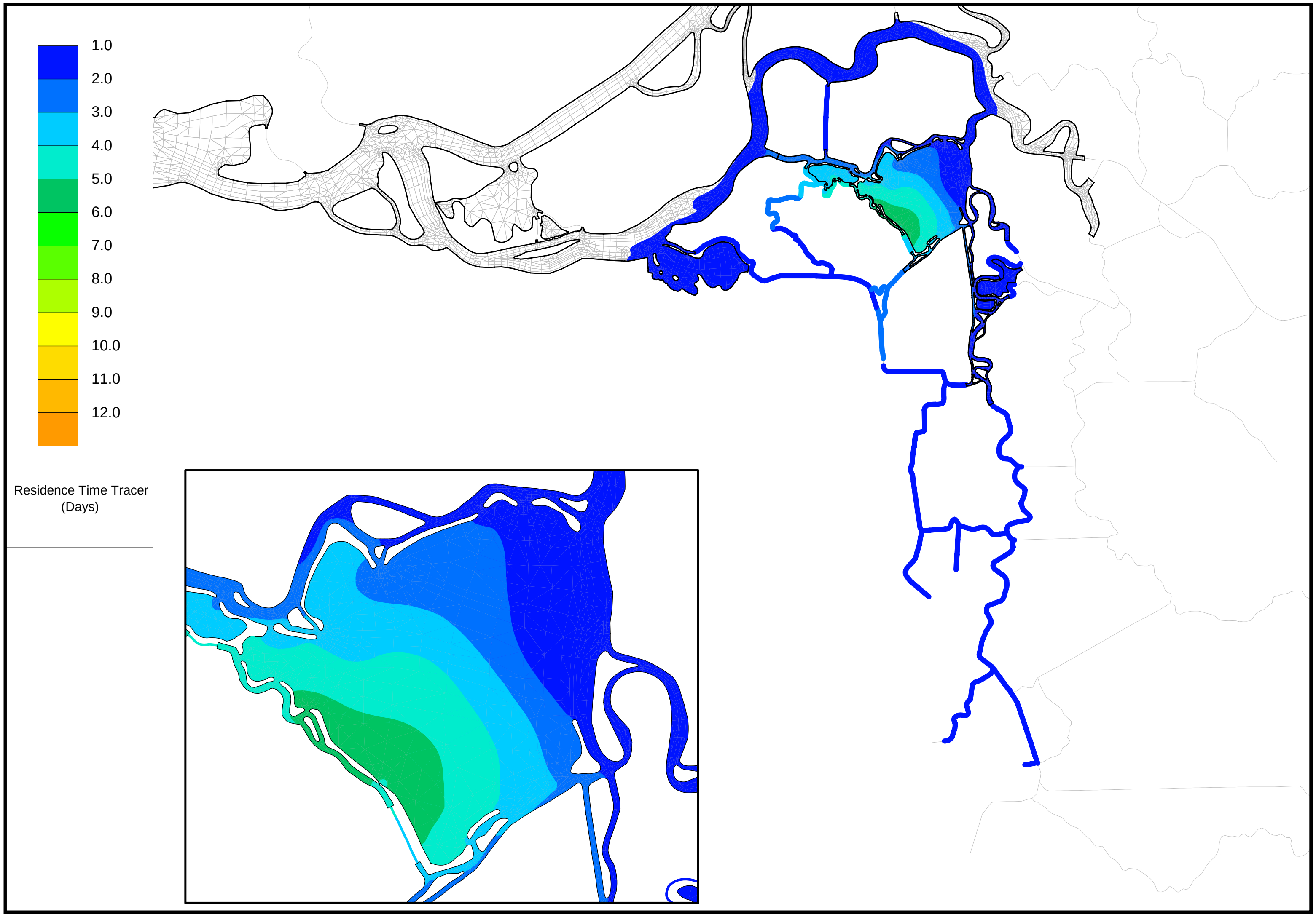

Figure 5-5 Contour plot of residence time for "West False River Gate 1/3 Flow" alternative on September 1 after 62 days of simulation.

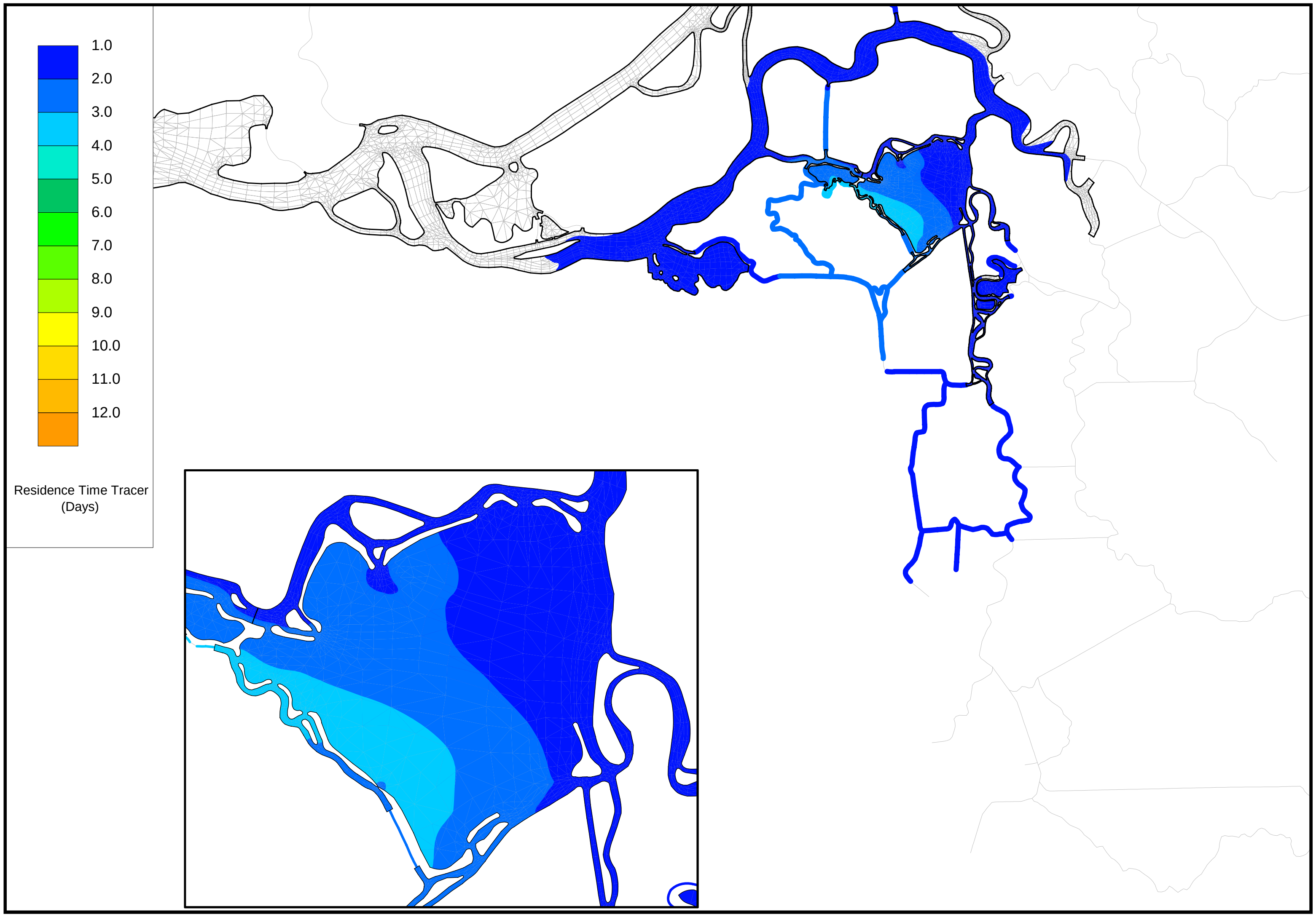

Figure 5-6 Contour plot of residence time for "False River and Piper Slough Gates" alternative on September 1 after 62 days of simulation.

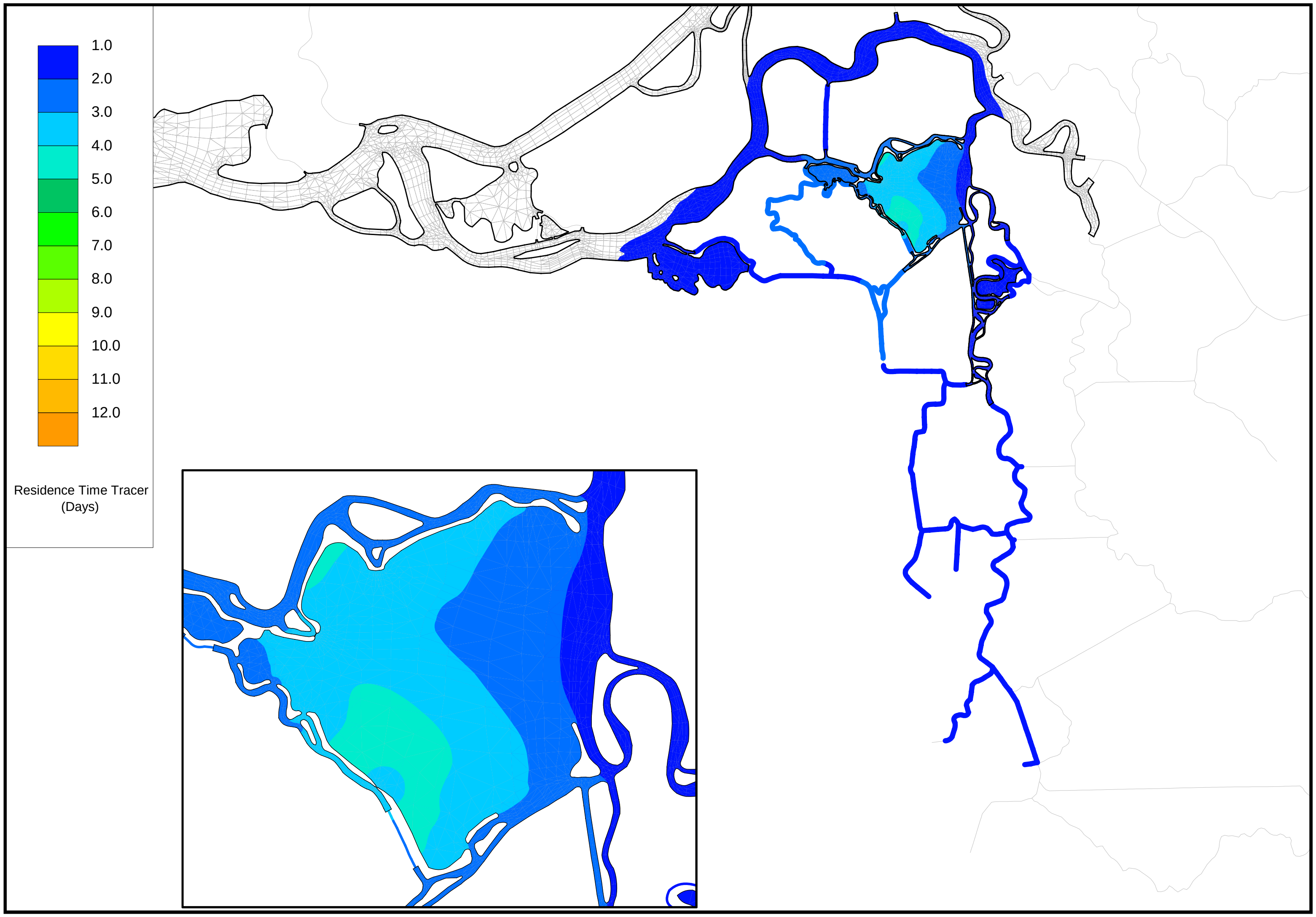

Figure 5-7 Contour plot of residence time for "North Levee and Nozzle Gate" alternative on September 1 after 62 days of simulation.

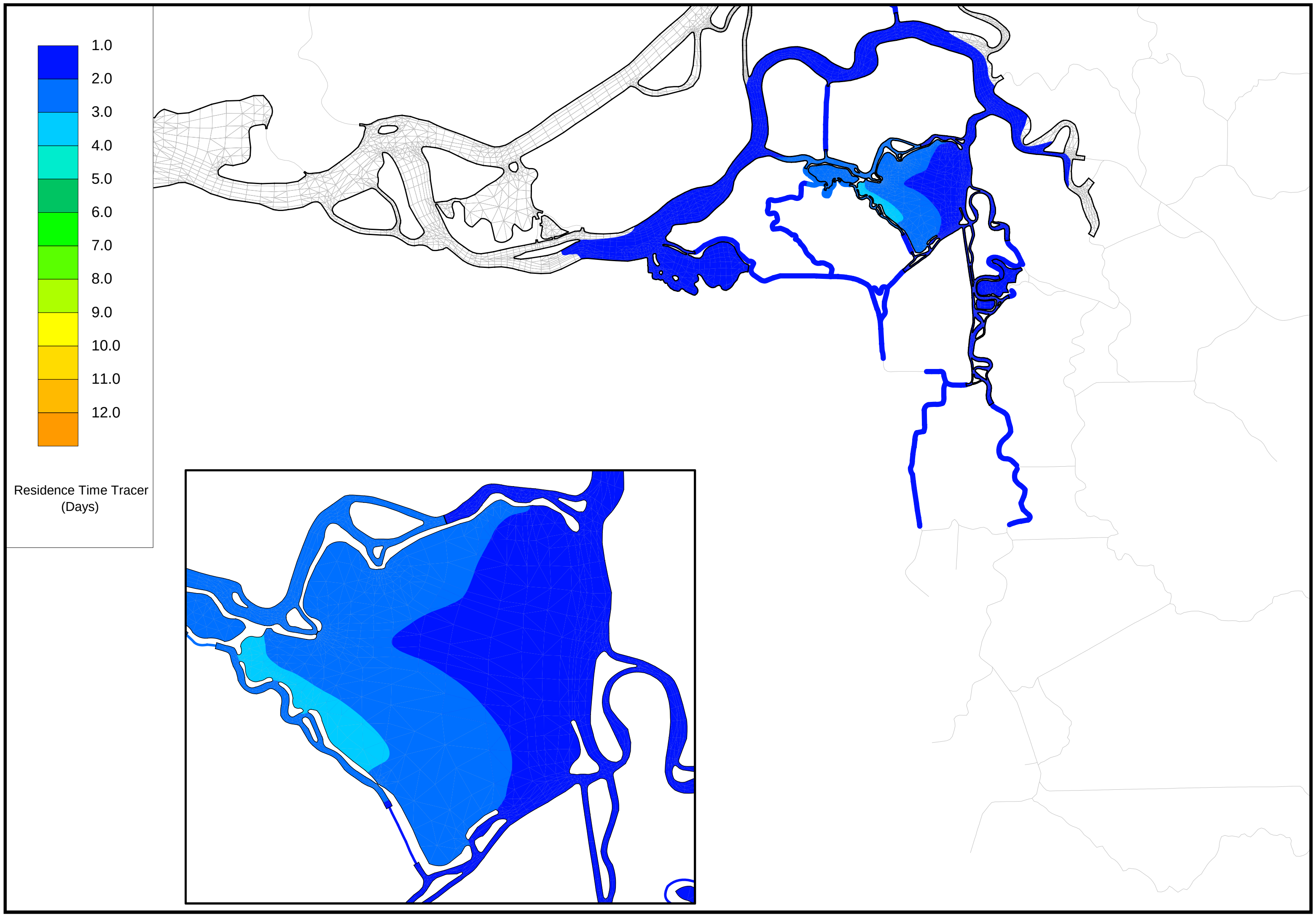

Figure 5-8 Contour plot of residence time for "North Levee, Nozzle Gate and Piper Slough Gate" alternative on Sept. 1 after 62 days of simulation.

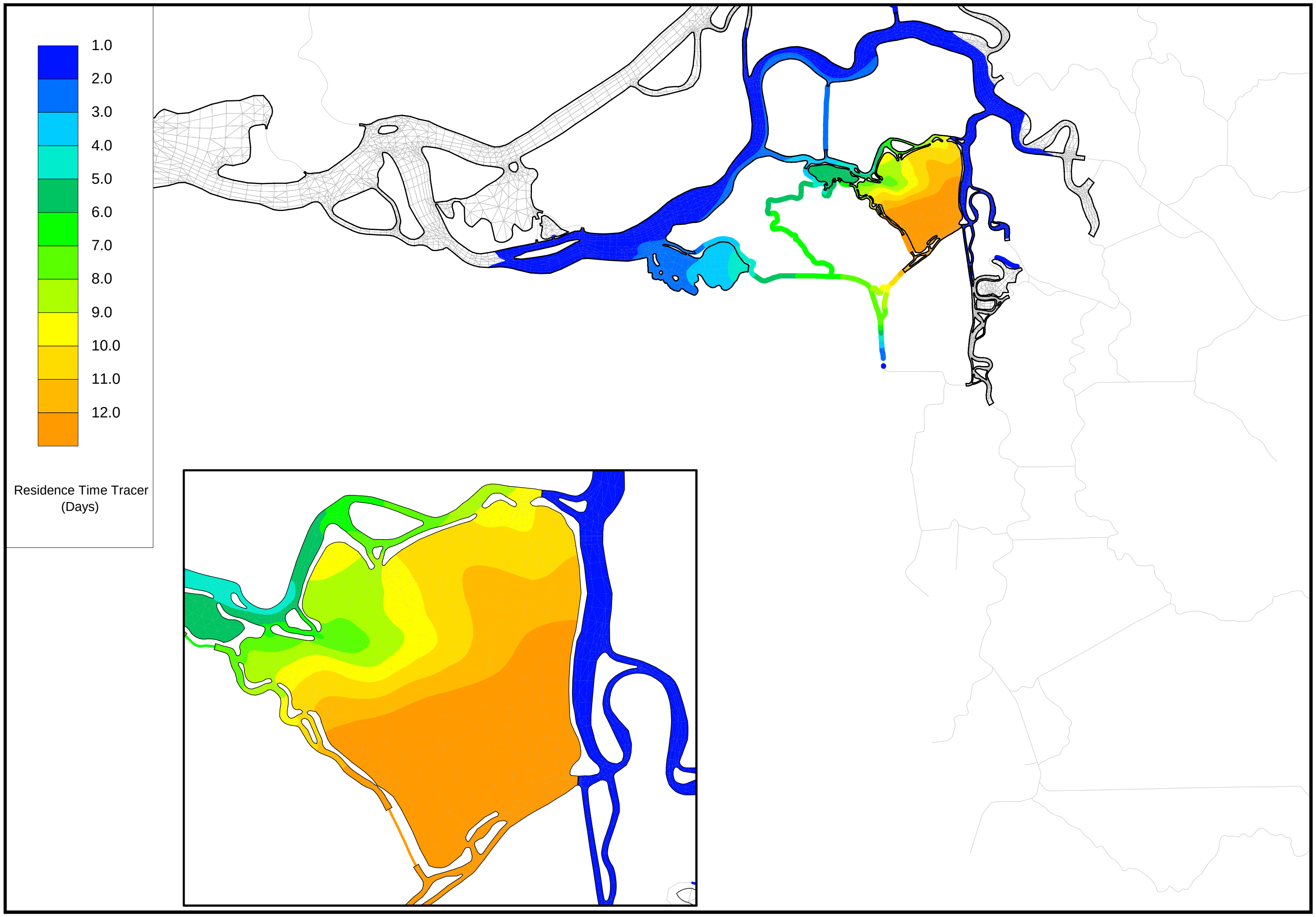

Figure 5-9 Contour plot of residence time for "East Levee and Gates" alternative on September 1 after 62 days of simulation.

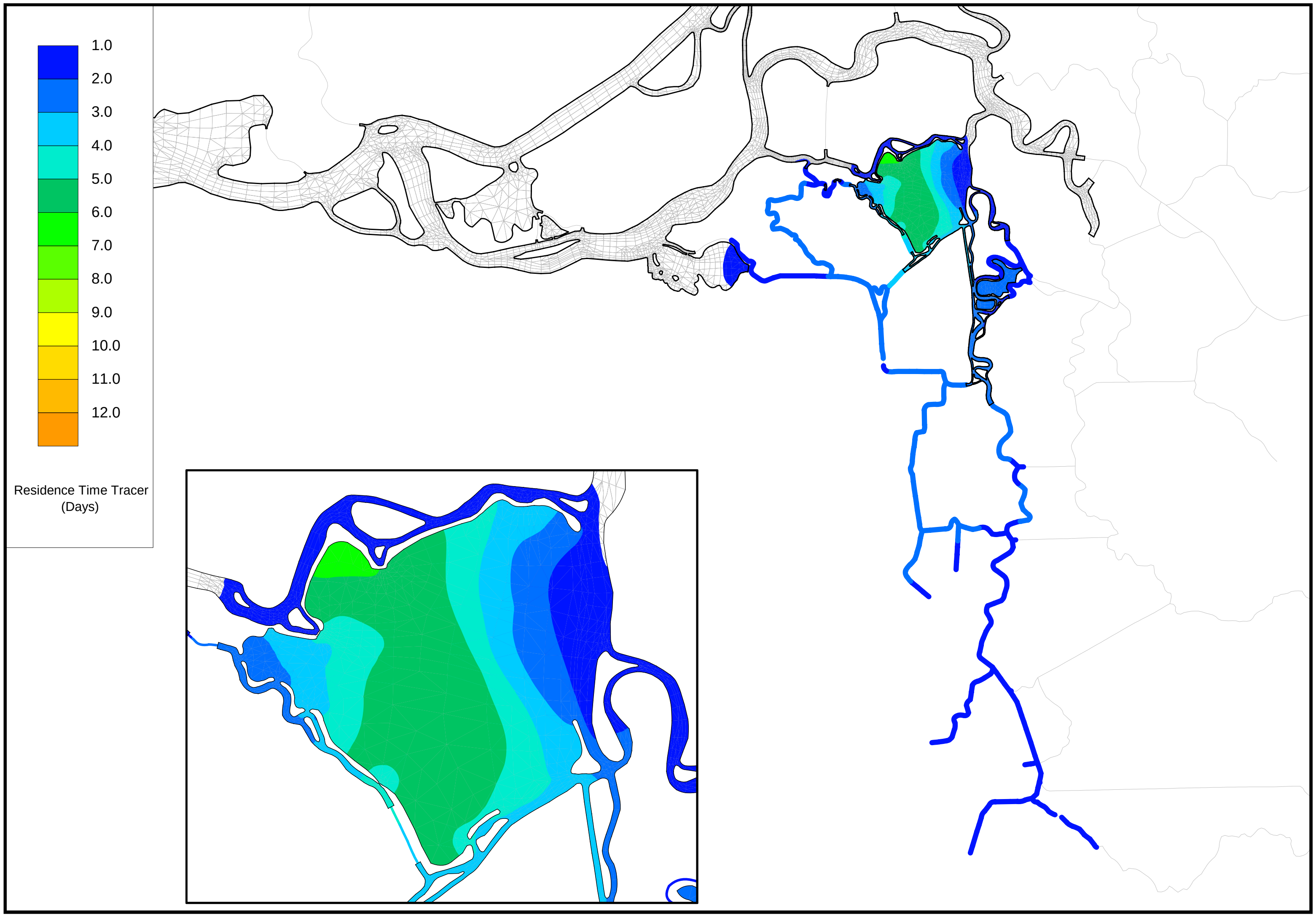

Figure 5-10 Contour plot of residence time for "North Levee and Close Little Franks Tract" alternative on September 1 after 62 days of simulation.

6 STAGE

There are two concerns regarding the impacts of the alternatives on Delta water surface elevations. During the summer months, the levees, barriers and gates associated with each alternative potentially will impede the free flow of water to the south Delta, drawing down the water surface there. Secondly, new or repaired levees around Franks Tract may reduce the capacity of the central Delta to convey flood waters, thus raising peak flood stages in the Delta.

Changes in minimum and maximum stage during July 2002 were examined for the “Cox Alternative” and “West False River Gate” alternatives, relative to Base case stages. The “Cox Alternative” was chosen for this analysis because it impedes flow towards the export pumps more than any other alternative. The “West False River Gate” alternative is examined because it has similarities to several other alternatives that may impact stage. Contour plots of change in stage relative to Base case for July are shown in Figures 6-1 through 6-4.

For the “Cox Alternative”, flow on Old River just south of Franks Tract is blocked. The Cox barriers impede the free flow of water to the South Delta more than any other alternative configuration. This alternative produces changes in minimum stage of no more than +/- 0.02 m (Figure 6-1). Stage decreases occur primarily south and west of Quimby Island and increases occur to the east. There is more impact on decreasing the maximum stage (Figure 6-2). Downstream of the barriers, the maximum stage is as much as 0.02 m higher, while south of the barriers the maximum stage is as much as 0.12 m lower. The largest decreases occur near the SWP and CVP intakes downstream of the ROLD046 barrier, and in Grant Line Canal.

The “West False River Gate” alternative decreases the minimum stage by no more than 0.01 m (Figure 6-3). The gate is open on ebb tide and closed on flood tide. As a result, flood flow into the Central and South Delta is impeded and the high tide elevation is reduced. Downstream of the gate, the maximum stage is as much as 0.02 m higher, and upstream of the gate the maximum stage is as much as 0.06 m lower (Figure 6-4).

Impacts on high tide stage during a flood event and an extreme high tide event were also analyzed. For this analysis, two sets of simulations were performed. The first set used hydrology for a flood event in January 1997. Net Delta outflow for the simulation period (January 1 through 10) is plotted in Figure 6-5. The second set of simulations used hydrology for a high tide period during February 1998. The stage at Martinez for the simulation period (February 1 though 10) is plotted in Figure 6-6.

For these simulations, all gates are open for winter time operation. Only alternatives which include some degree of levee constriction will alter the flow in the Delta channels relative to the Base condition. Therefore, only the “East Side Open”, “North Levee and Nozzle Gate” and “East Levee and Gates” alternatives were simulated for the flood event and only the “East Side Open” and “East Levee and Gates” alternatives were simulated for the extreme high tide event.

Contour plots of change in maximum stage for the “East Side Open”, “North Levee and Nozzle Gate” and “East Levee and Gates” alternatives relative to the Base case are plotted in Figures 6-7 through 6-9 for the January 1997 flood event. Contour plots of change in maximum stage for of the “East Side Open” and “East Levee and Gates” alternatives relative to the Base case are plotted in Figures 6-10 and 6-11 for the February 1998 high tide event.

During the January 1997 flood event, the “East Side Open” alternative produces increases in maximum stage of as much as 0.04 m, with the greatest increases occurring in Franks Tract. Maximum stage decreases by as much as 0.04 m on the west side of the False River constriction.

The “North Levee and Nozzle Gate” alternative has virtually no impact on maximum stage during the flood event.

The “East Levee and Gates” alternative decreases maximum stage in Franks Tract during the flood even by approximately 0.01 m. South of Franks Tract to about Victoria Canal, maximum stages in Old River and Middle River are increased by 0.01m.

During the February 1998 high tide simulation, the “East Side Open” alternative resulted in maximum stage decreases ranging from 0.01 to 0.05 m throughout much of the Delta.

The largest decreases occur in Piper Slough and False River west of the constriction.

The “East Levee and Gates” alternative causes almost no change in maximum stage during the high tide simulation. Only within Franks Tract does the maximum stage decrease by 0.01 m.

Figure 6-1 Change in minimum stage during July for the "Cox Alternative".

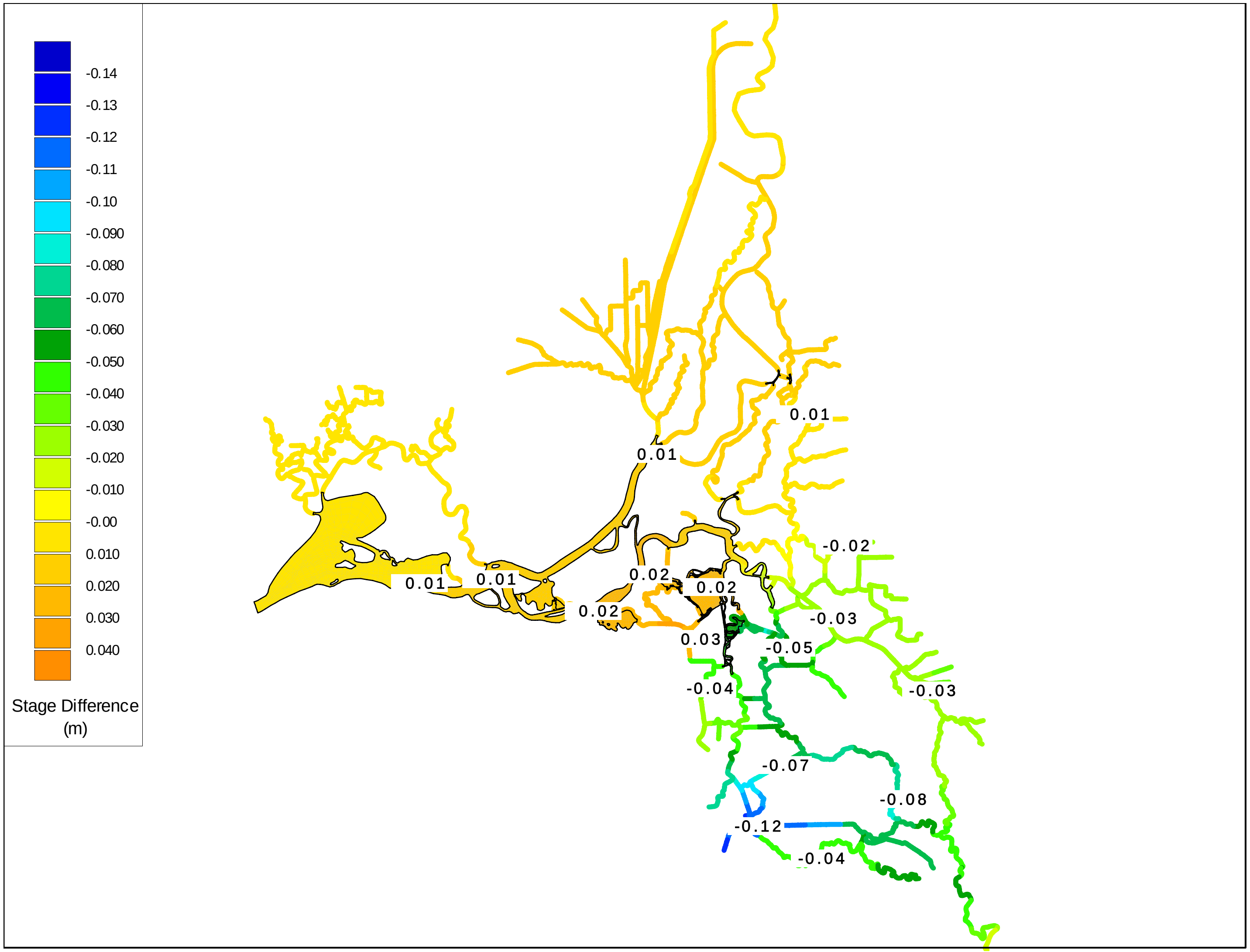

Figure 6-2 Change in maximum stage during July for the "Cox Alternative".

Figure 6-3 Change in minimum stage during July for the "West False River Gate" alternative.

Figure 6-4 Change in maximum stage during July for the "West False River Gate" alternative.

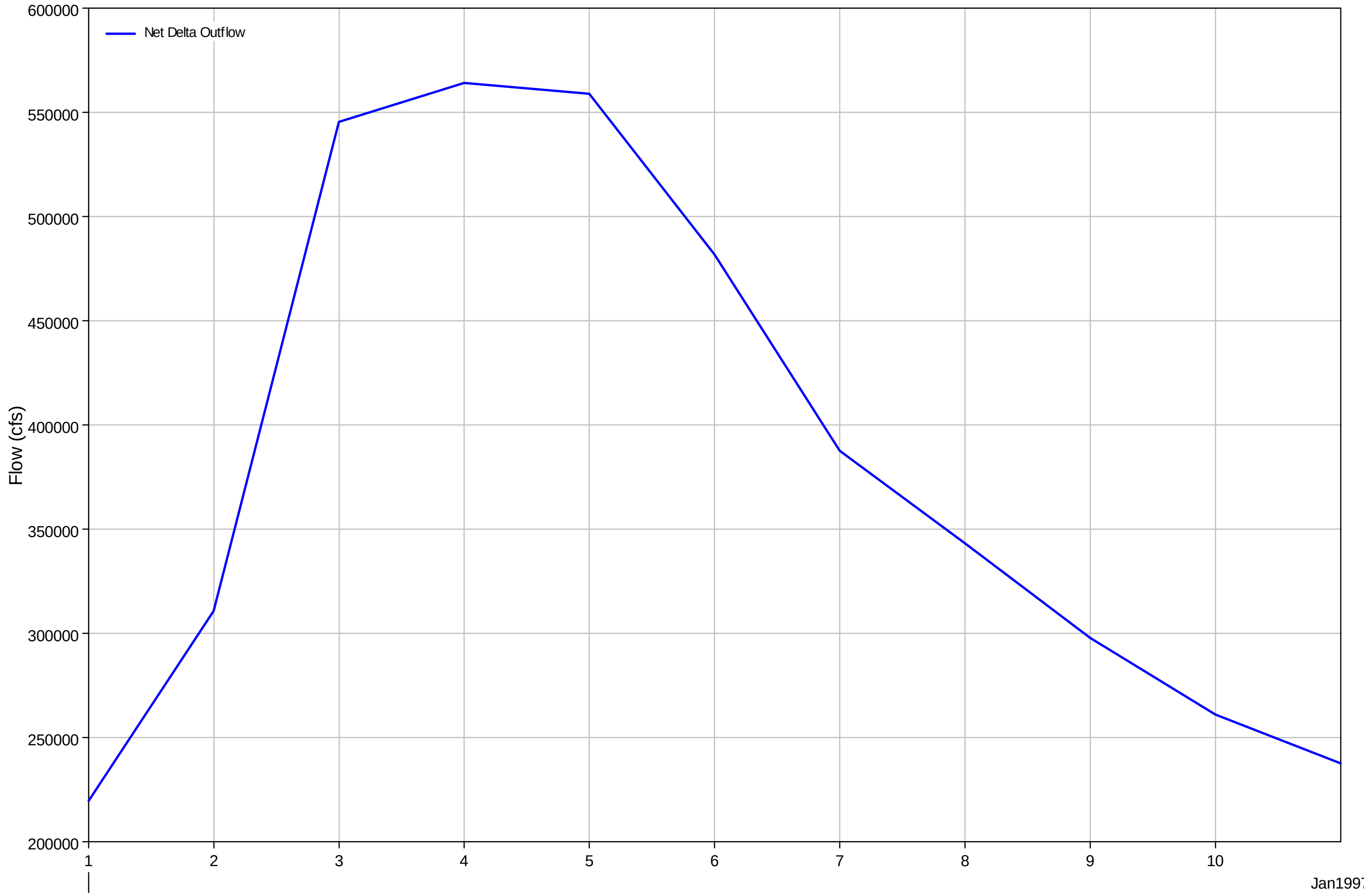

Figure 6-5 Net Delta outflow for January 1997 flood simulation.

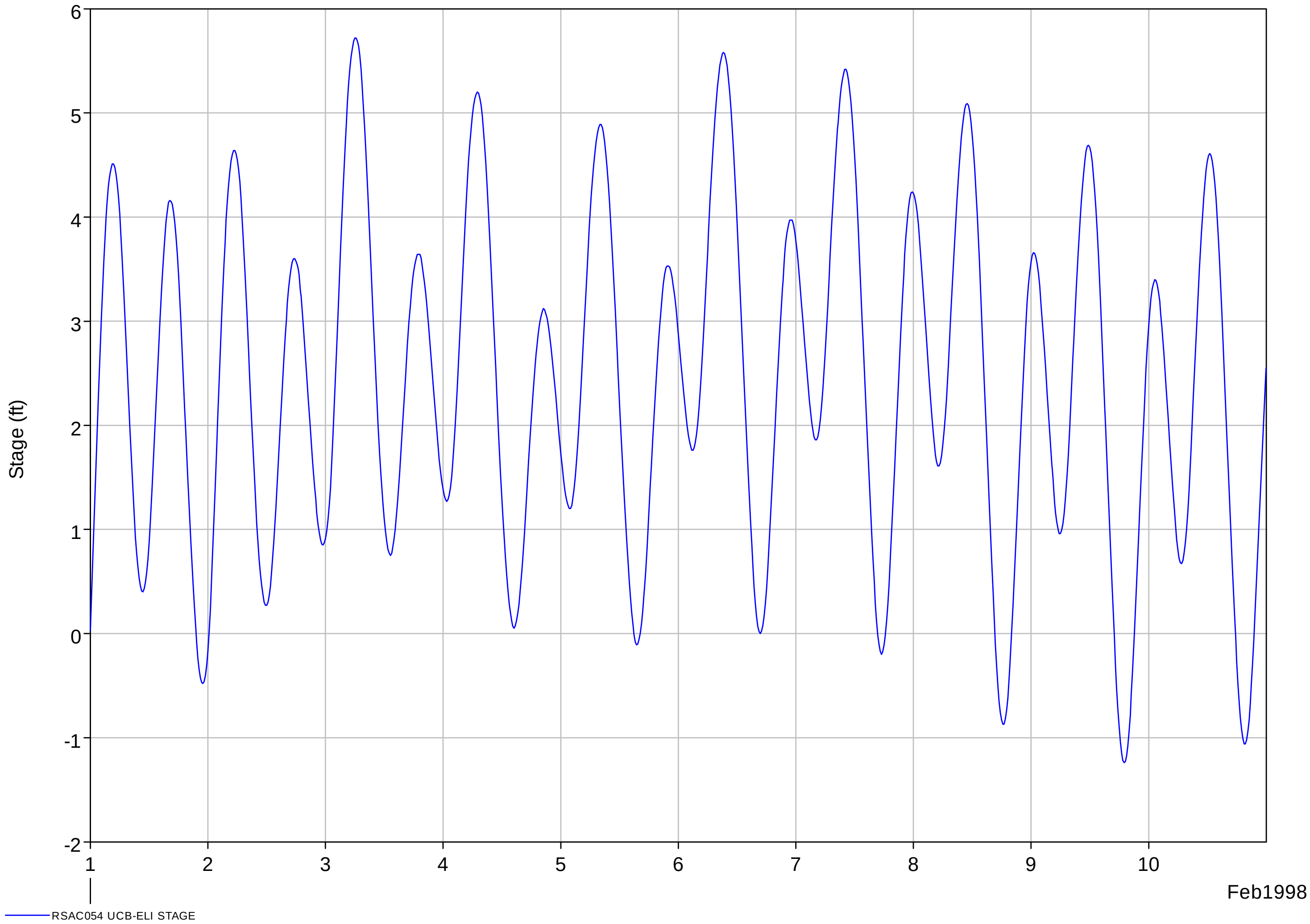

Figure 6-6 Martinez stage for February 1998 high tide simulation.

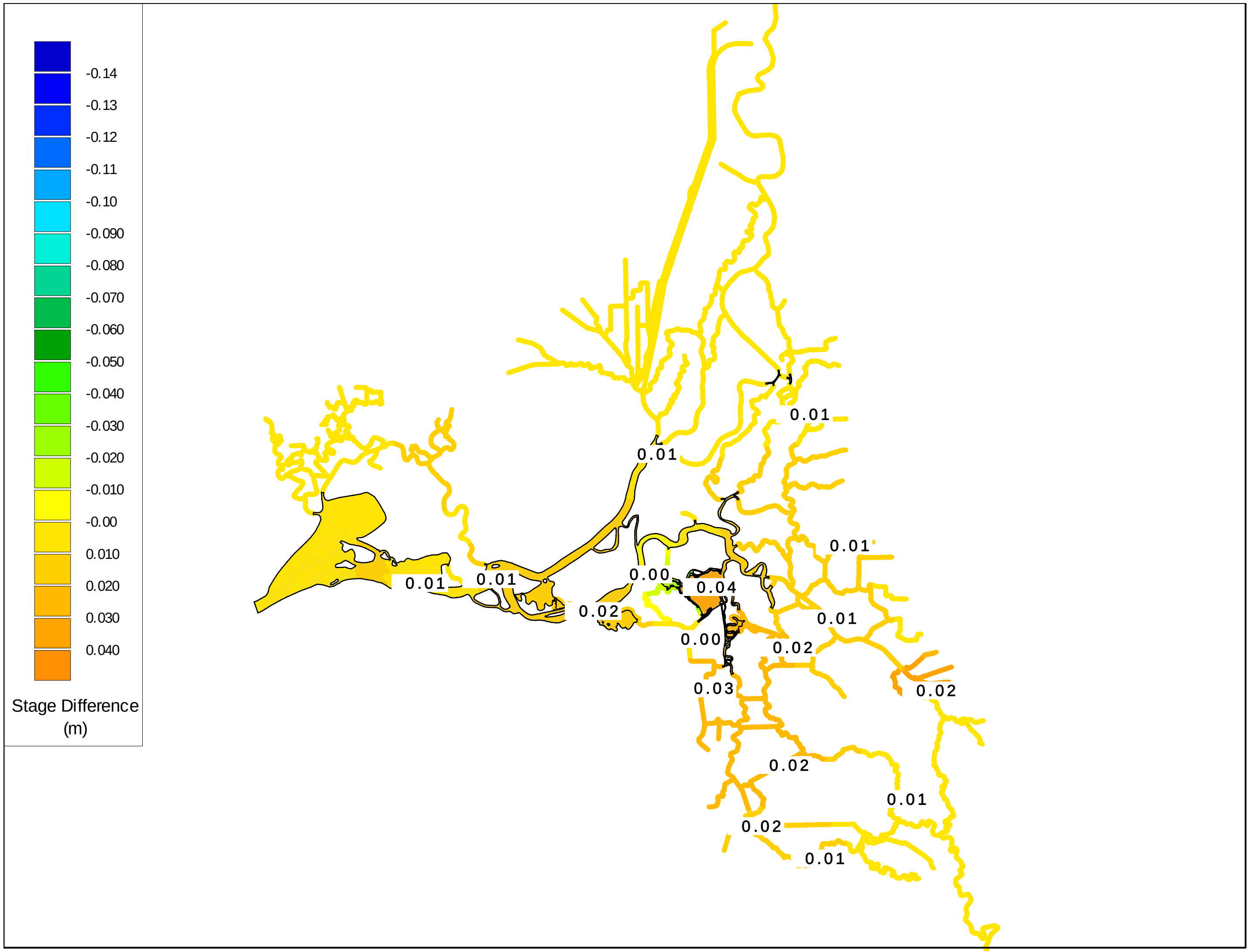

Figure 6-7 Change in maximum stage during the January 1997 flood event for the "East Side Open" alternative.

Figure 6-8 Change in maximum stage during the January 1997 flood event for the "North Levee and Nozzle Gate" alternative.

Figure 6-9 Change in maximum stage during the January 1997 flood event for the "East Levee and Gates" alternative.

Figure 6-10 Change in maximum stage during the February 1998 high tide for the "East Side Open" alternative.

Figure 6-11 Change in maximum stage during the February 1998 high tide for the "East Levee and Gates" alternative.

7 VELOCITY

To examine the impact of the alternatives on peak velocity, contour plots of peak velocity magnitude and change in peak velocity from the Base condition are provided in Figures 7-2 through 7-11. Peak velocities for the Base case are plotted in Figure 7-1. Peak velocities were computed for the period of July 10, 2002 at 12:00 through July 12, 2002 at 12:00, during a spring tide condition (see Figure 3-1).

For the “Franks Tract Closed” alternative (Figure 7-2), peak velocities in False River near Old River are increased by approximately 0.9 m/s. Increases in Piper Slough near Sand Mound Slough are as high as 0.6 m/s. Near the nozzle, velocities are decreased by 0.9 m/s.

The “East Side Open” alternative (Figure 7-3) causes peak velocity increases of 0.5 m/s in Fisherman’s Cut and in Old River near False River. In Piper Slough near Sand Mound Slough, peak velocity increases by 0.6 m/s. Overall velocities in Franks Tract are reduced.

With the “Cox Alternative”, flow which would normally move down Old River and Holland Cut is rerouted to Middle River. Consequentially, peak velocities increase by as much as 0.6 m/s in Middle River between San Joaquin River and Mildred Island, and in Connection Slough adjacent to the south end of Mandeville Island (Figure 7-4). Peak velocities are near zero in Old River and Holland Cut north of the barriers and for much of the southeast corner of Franks Tract.

For the “West False River Gate” alternative (Figure 7-5), peak velocities in Fisherman’s Cut are increased by as much as 0.7 m/s and in Old River near San Joaquin River they are increased by as much as 0.5 m/s. Peak velocities near the nozzle are decreased by as much as 0.3 m/s.

With the “West False River Gate 1/3 Open” alternative (Figure 7-6), the increases in Fisherman’s Cut and Old River are similar to the fully open gate, however decreased velocities by as much as 0.8 m/s are seen in False River because only 1/3 of the flow is allowed through on ebb tide. This impacts the nozzle as well, where peak velocities are decreased by about 0.4 m/s. Overall peak velocities in Franks Tract are reduced.

For the “False River and Piper Slough Gates” alternative (Figure 7-7), peak velocities are increased by 0.6 m/s in Fisherman’s Cut and 0.5 m/s in Old River near San Joaquin River. Peak velocities near the nozzle are decreased by as much as 0.4 m/s.

For the “North Levee and Nozzle Gate” alternative (Figure 7-8), peak velocities in False River near Old River are increased by approximately 0.8 m/s. Near the nozzle, velocities are decreased by 0.3 m/s. Peak velocity changes in Piper Slough range from +0.2 m/s along Little Franks Tract to near zero at the southeast end of the slough.

For the “North Levee, Nozzle Gate and Piper Slough Gate” alternative (Figure 7-9), peak velocities in Fisherman’s Cut are increased by 0.5 m/s and in Old River near False River they are increased by 0.6 m/s. Peak velocities near the nozzle are increased by as much as 1.1 m/s. There is little or no increase in Piper Slough. Peak velocities increase by approximately 0.1 m/s through out most of Taylor Slough. Near its junction with Dutch slough, peak velocities are increased by 0.4 m/s.

For the “East Levee and Gates” alternative (Figure 7-10), peak velocities in Fisherman’s Cut and in Old River east of Franks Tract are increased by 0.5 m/s. Near the Sand Mound Slough Gate, peak velocities decrease by as much as 0.7 m/s to near zero. Velocities on the eastern side of Franks Tract are greatly diminished.

For the “North Levee and Close Little Franks Tract” alternative (Figure 7-11), peak velocities in False River near Old River are increased by approximately 0.9 m/s. Overall velocities in Franks Tract are reduced. In Piper Slough peak velocity changes are generally between -0.1 m/s (along Franks Tract) to +0.2 m/s (along little Franks Tract). At the horseshoe bend on Bethel Island, peak velocities are increased by 0.3 m/s.

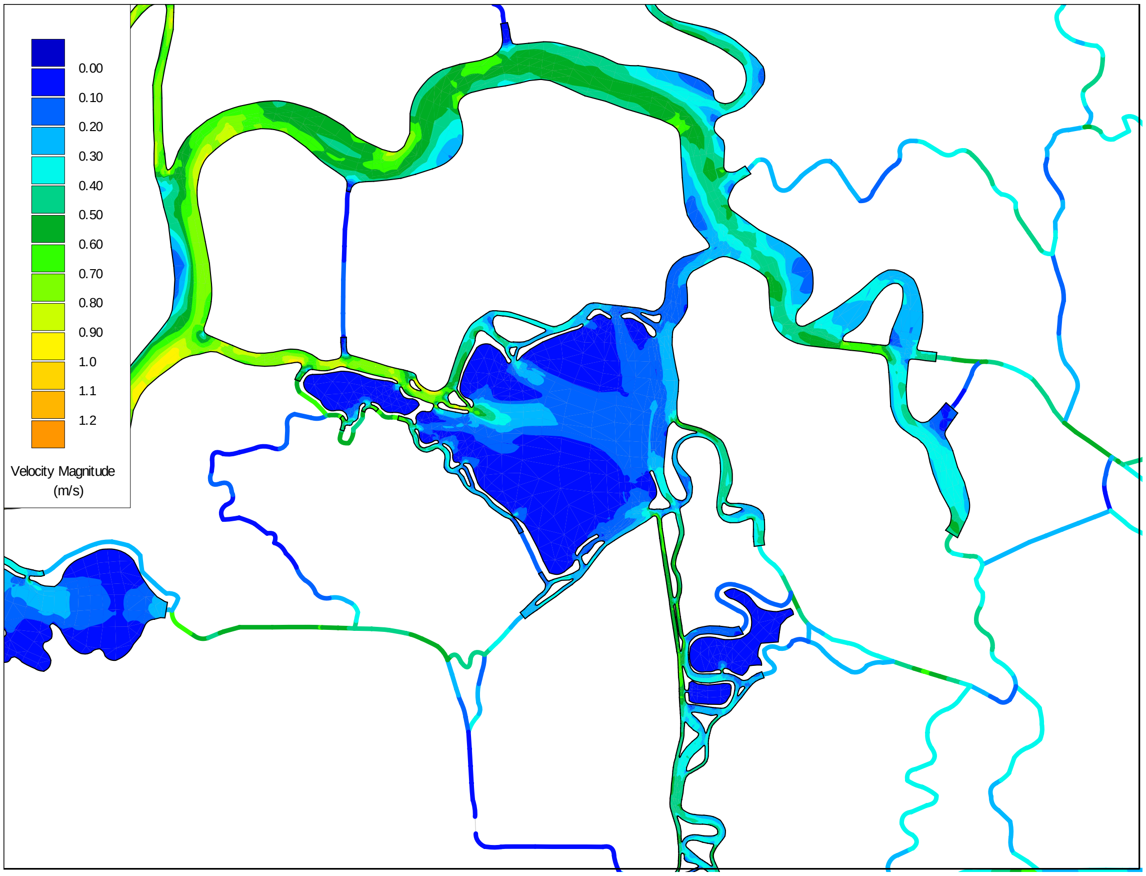

Figure 7-1 Base case peak velocity magnitude during July 10 12:00 through July 12 12:00.

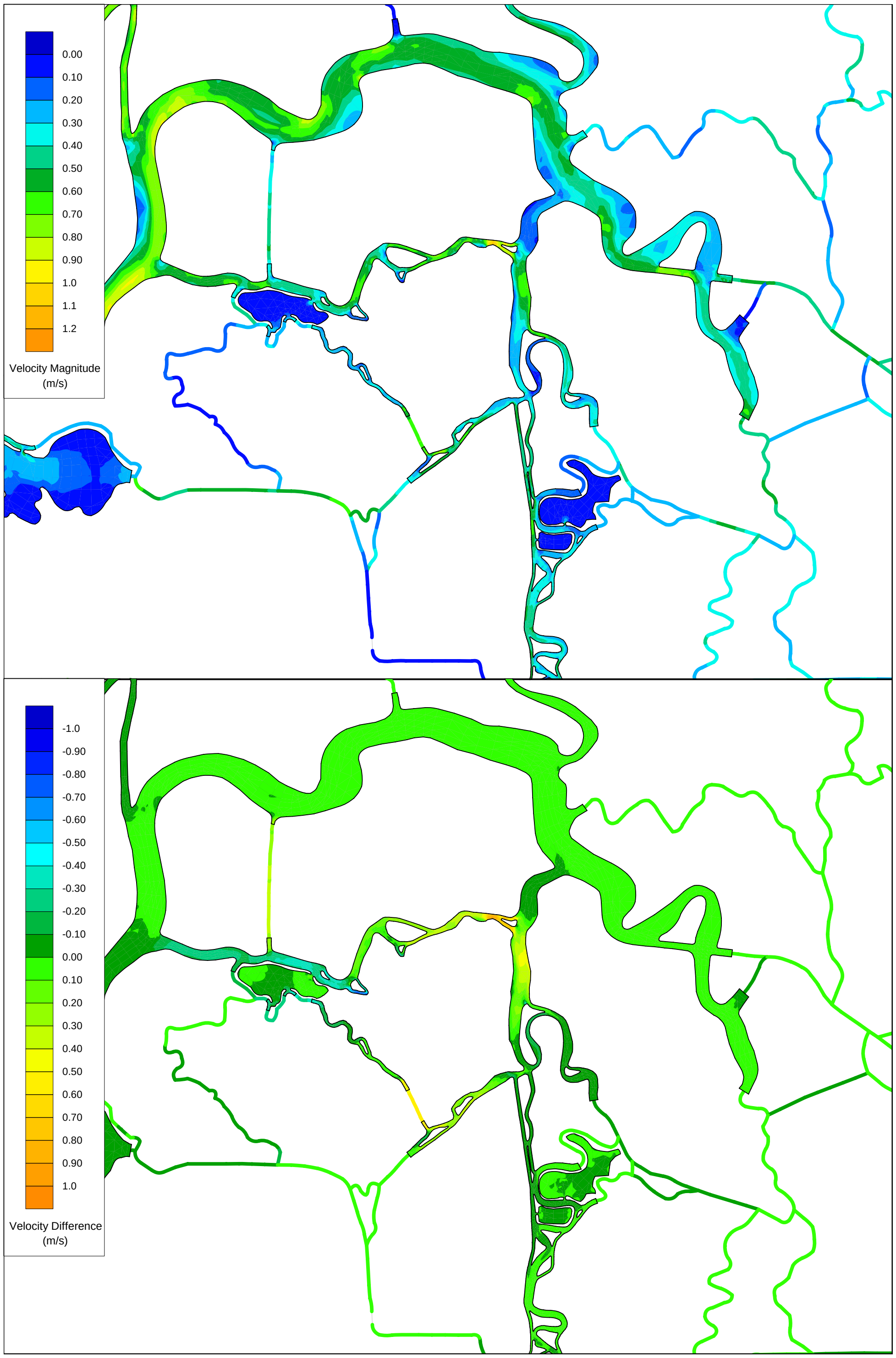

Figure 7-2 "No Franks Tract" alternative: peak velocity magnitude and change in peak velocity from Base case during July 10 12:00 through July 12 12:00.

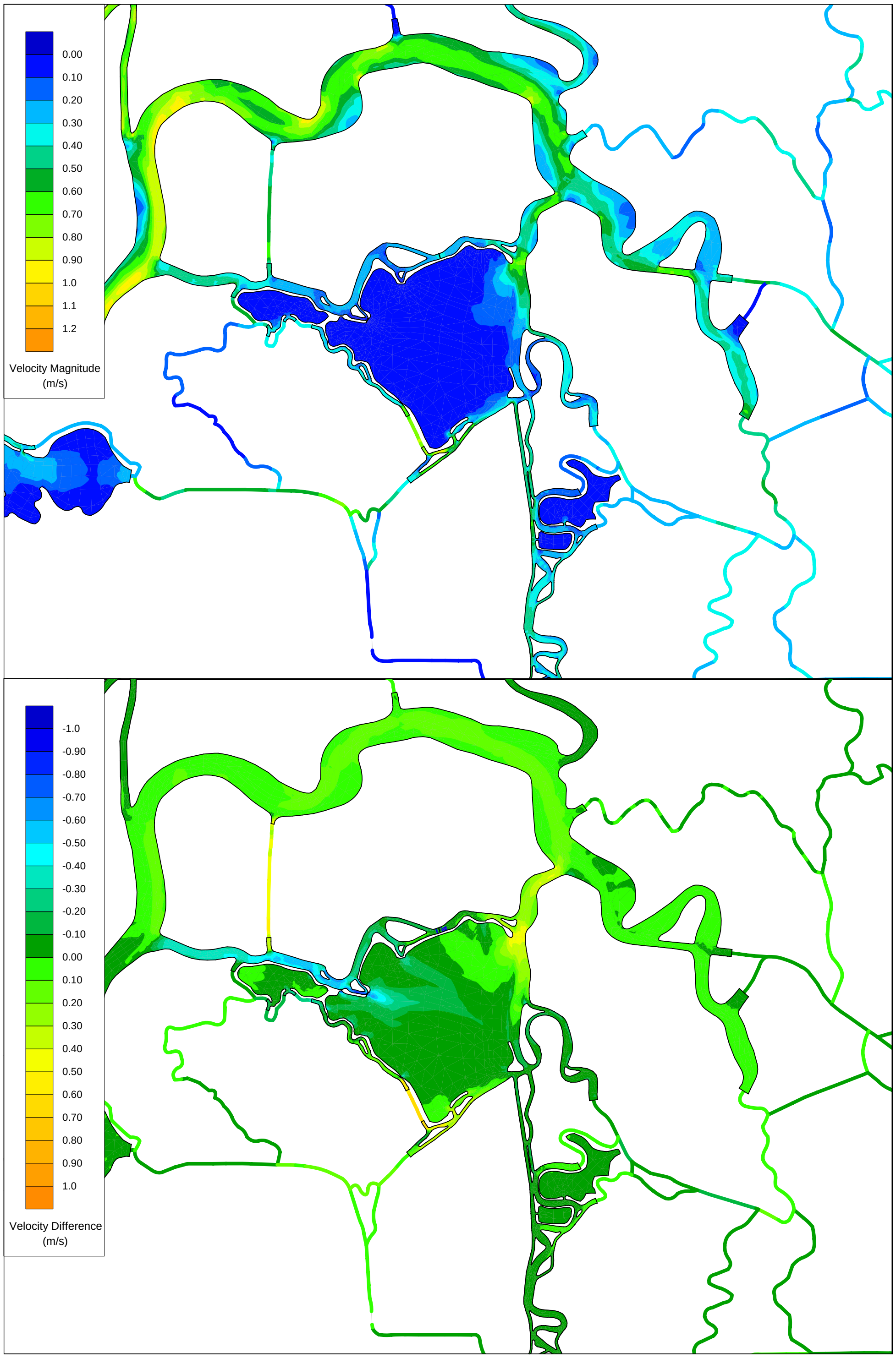

Figure 7-3 "East Side Open" alternative: peak velocity magnitude and change in peak velocity from Base case during July 10 12:00 through July 12 12:00.

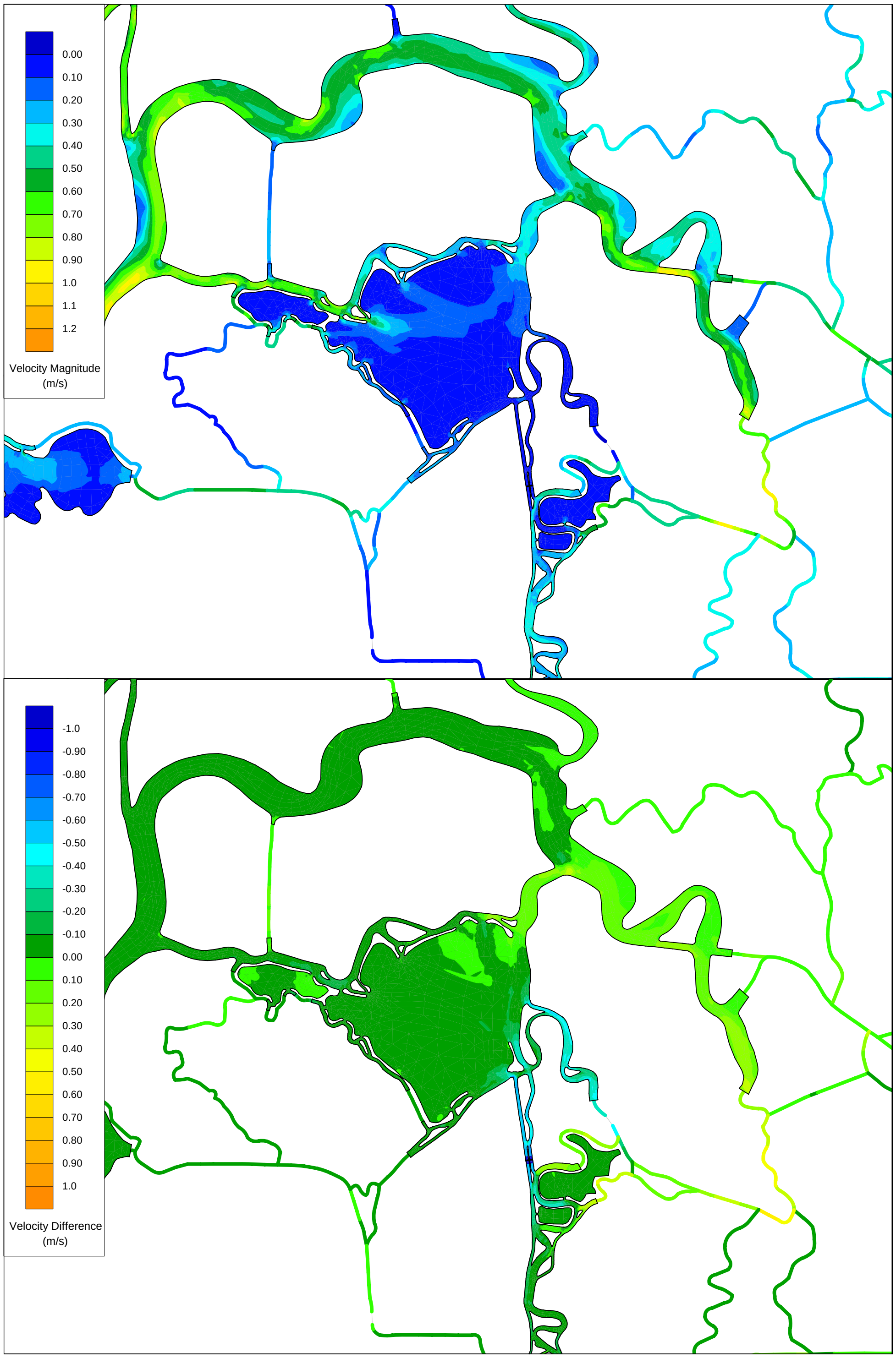

Figure 7-4 "Cox Alternative": peak velocity magnitude and change in peak velocity from Base case during July 10 12:00 through July 12 12:00.

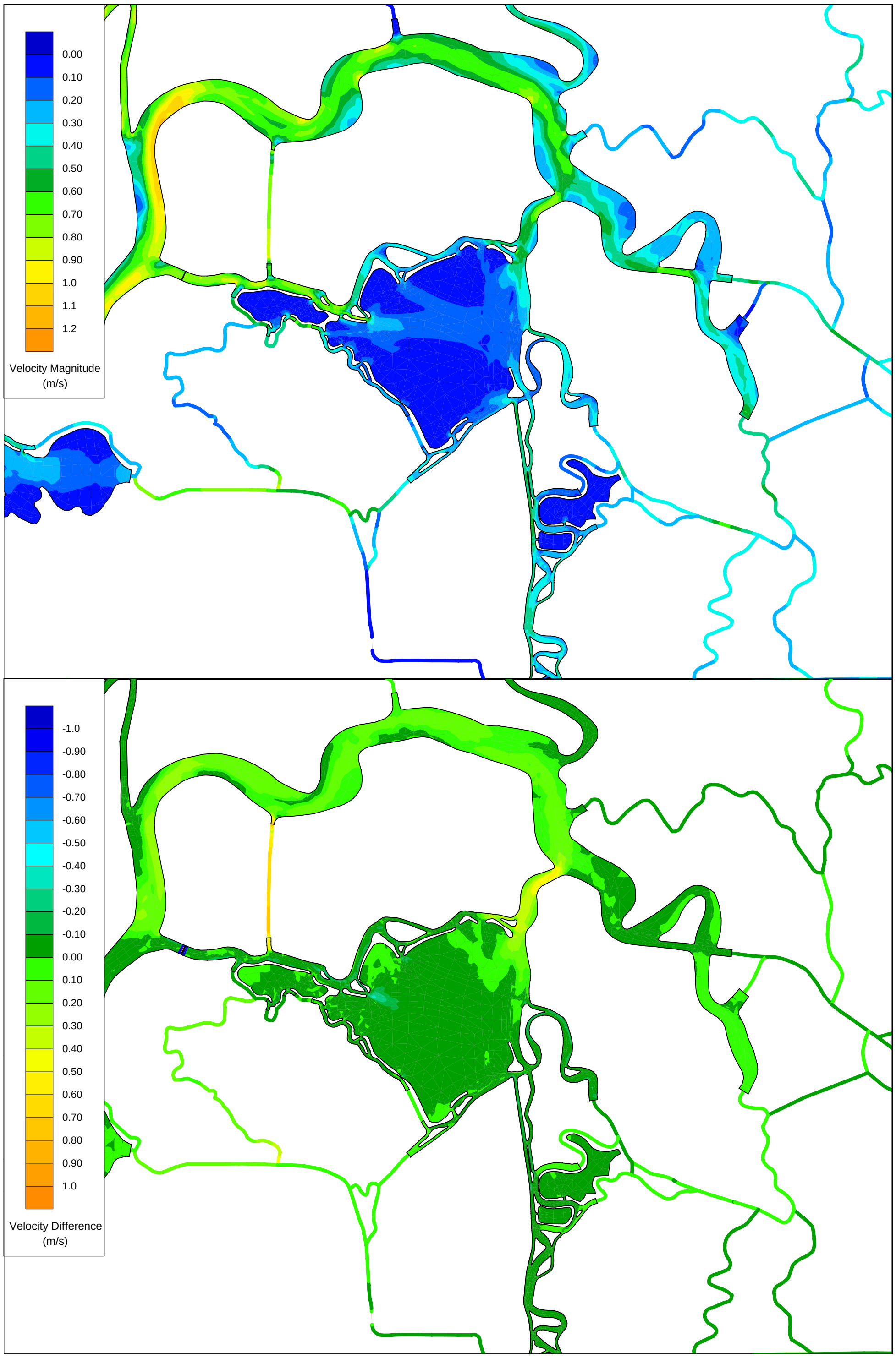

Figure 7-5 "West False River Gate" alternative: peak velocity magnitude and change in peak velocity from Base case during July 10 12:00 through July 12 12:00.

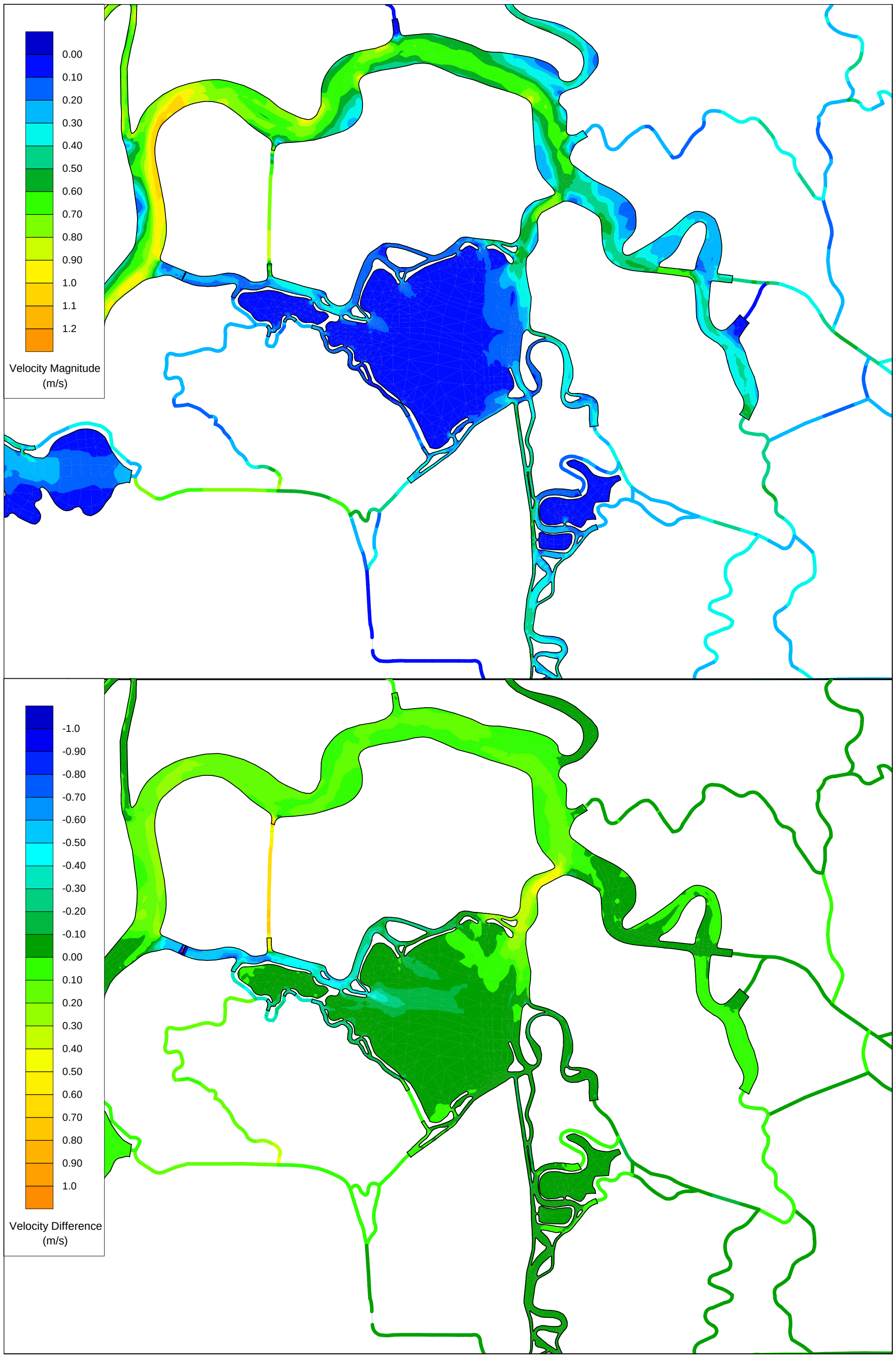

Figure 7-6 "West False River Gate 1/3 Flow" alternative: peak velocity magnitude and change in peak velocity from Base case during July 10 12:00 through July 12 12:00.

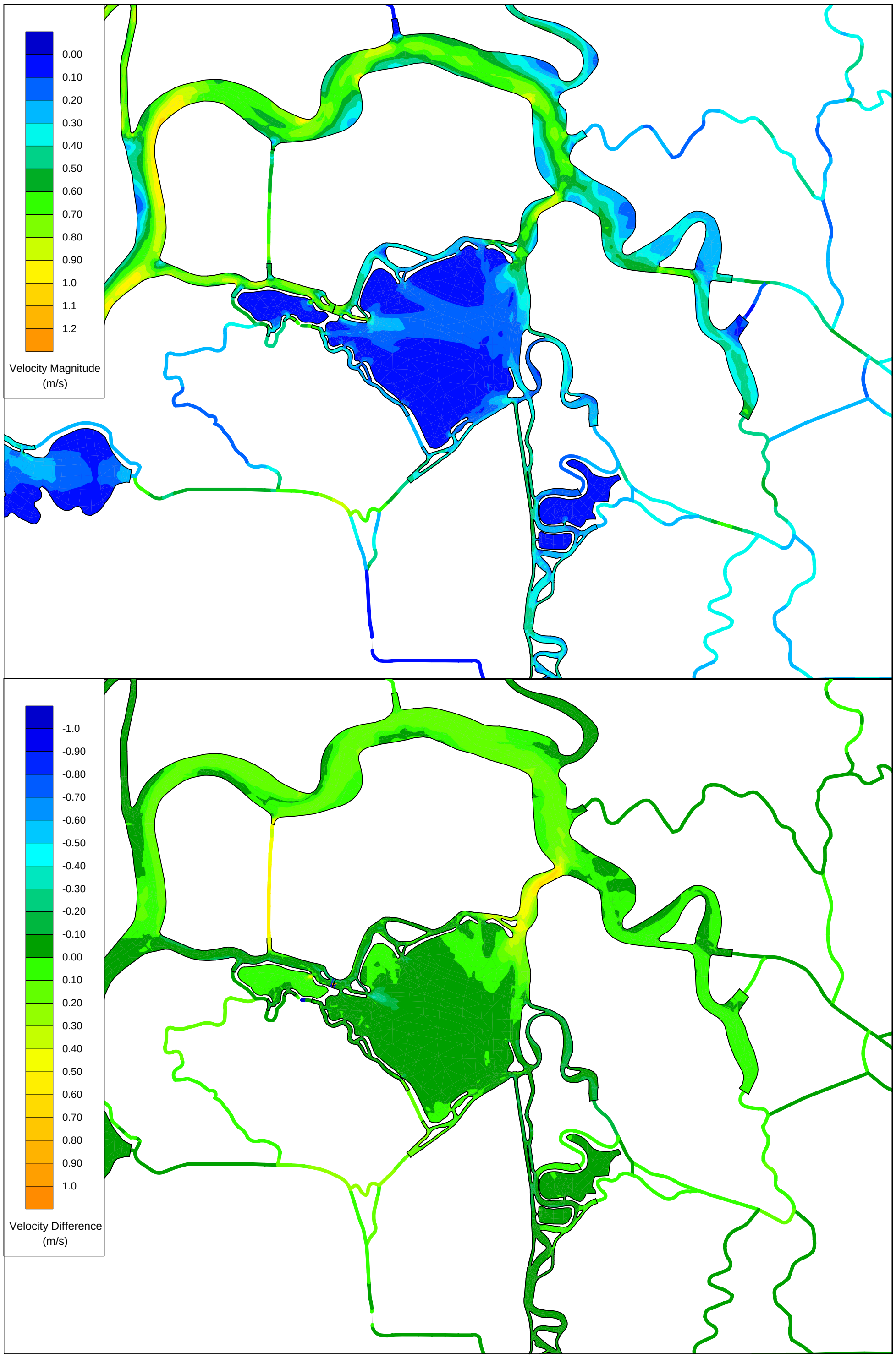

Figure 7-7 "False River and Piper Slough Gates" alternative: peak velocity magnitude and change in peak velocity from Base case during July 10 12:00 through July 12 12:00.

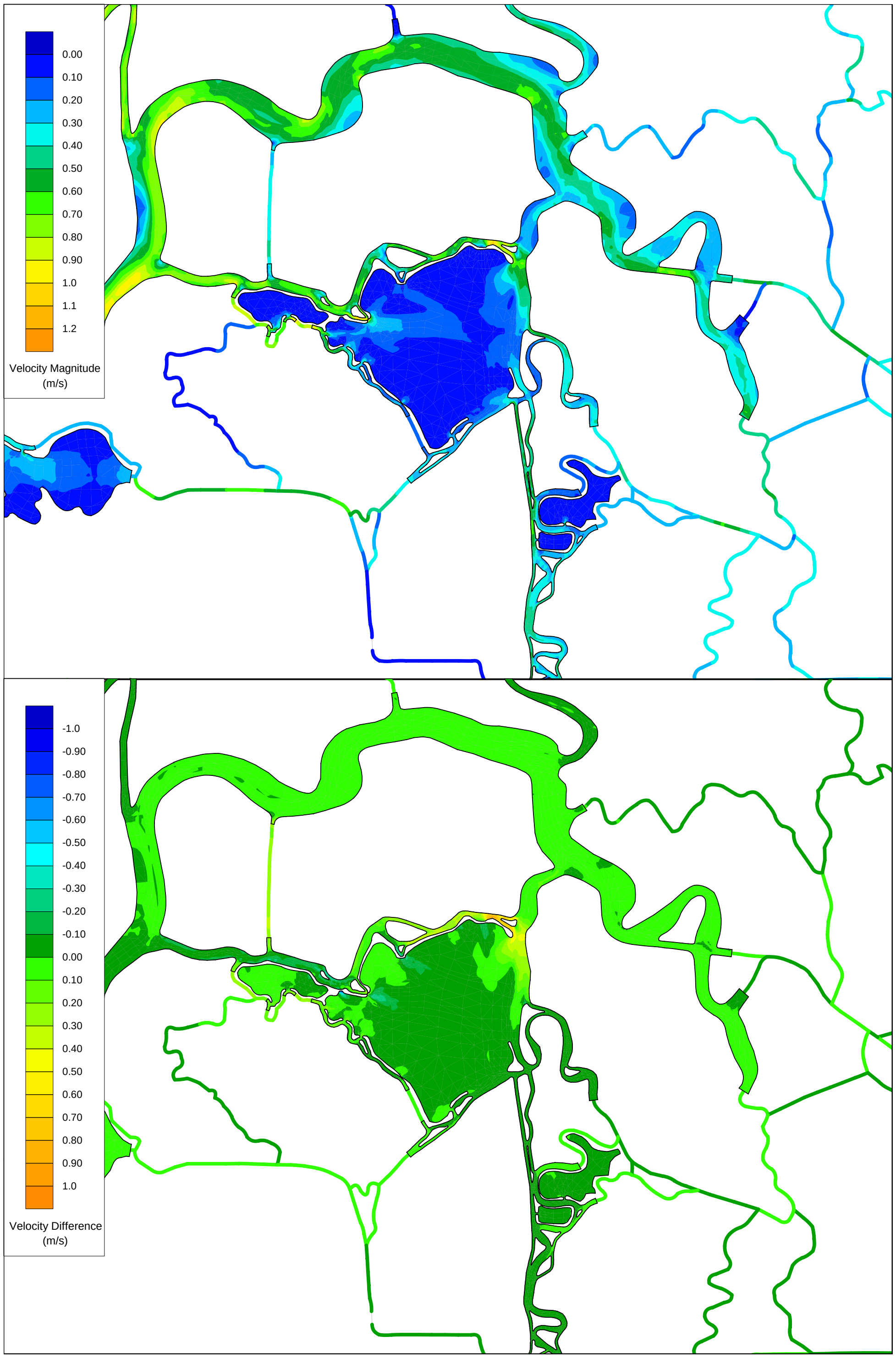

Figure 7-8 "North Levee and Nozzle Gate" alternative: peak velocity magnitude and change in peak velocity from Base case during July 10 12:00 through July 12 12:00.

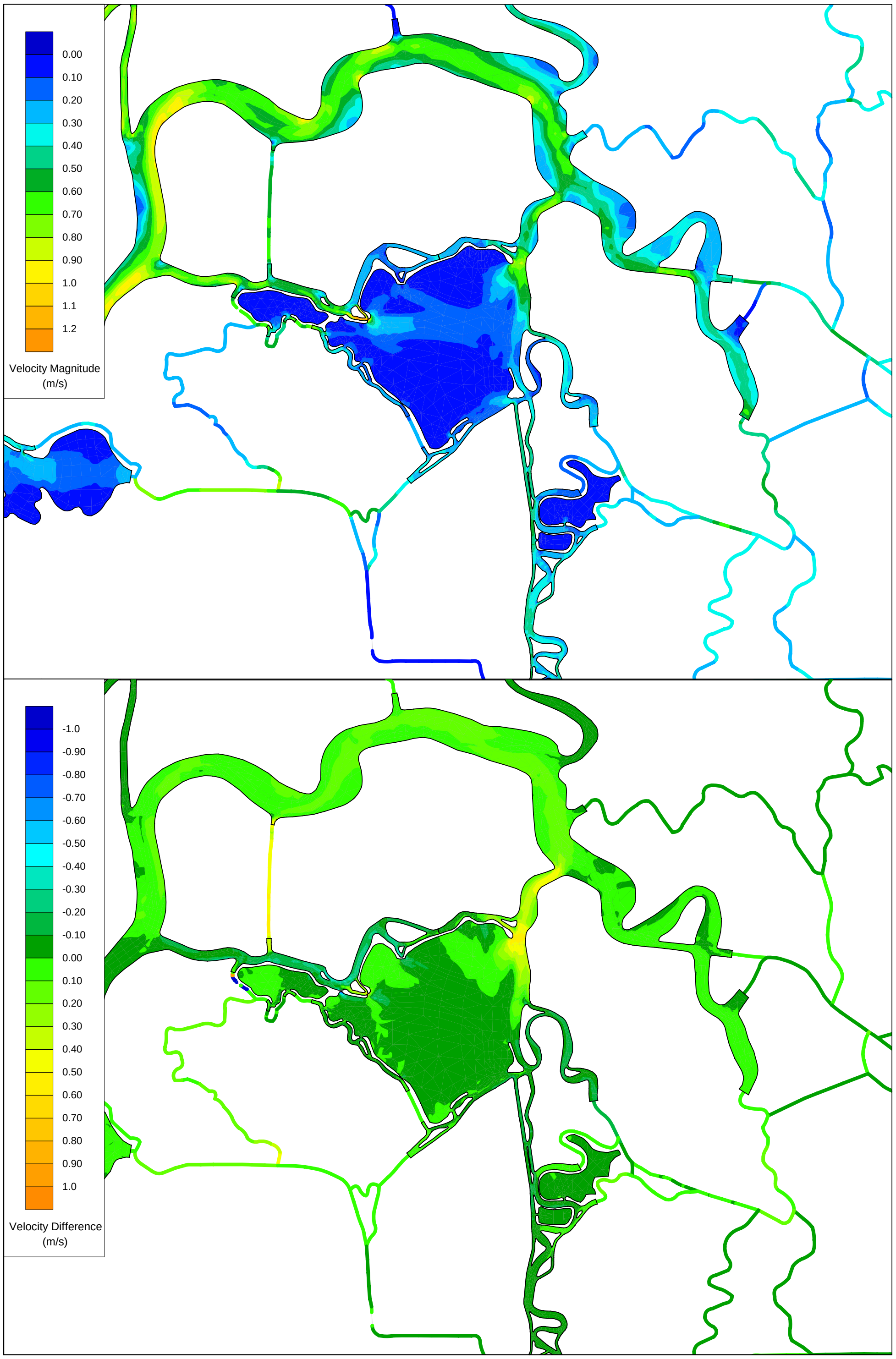

Figure 7-9 "North Levee, Nozzle Gate and Piper Slough Gate" alternative: peak velocity magnitude and change in peak velocity from Base case during July 10 12:00 through July 12 12:00.

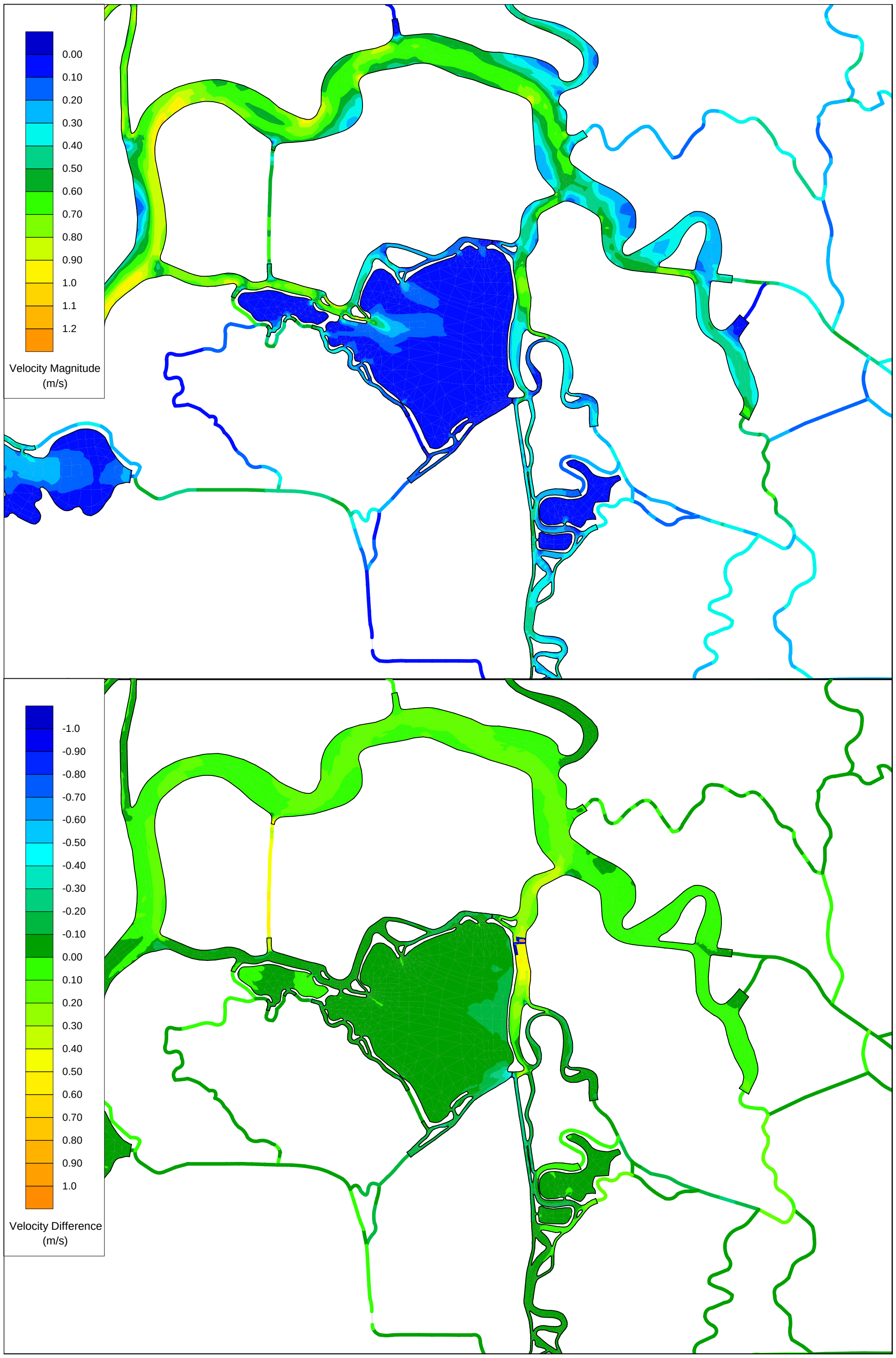

Figure 7-10 "East Levee and Gates" alternative: peak velocity magnitude and change in peak velocity from Base case during July 10 12:00 through July 12 12:00.

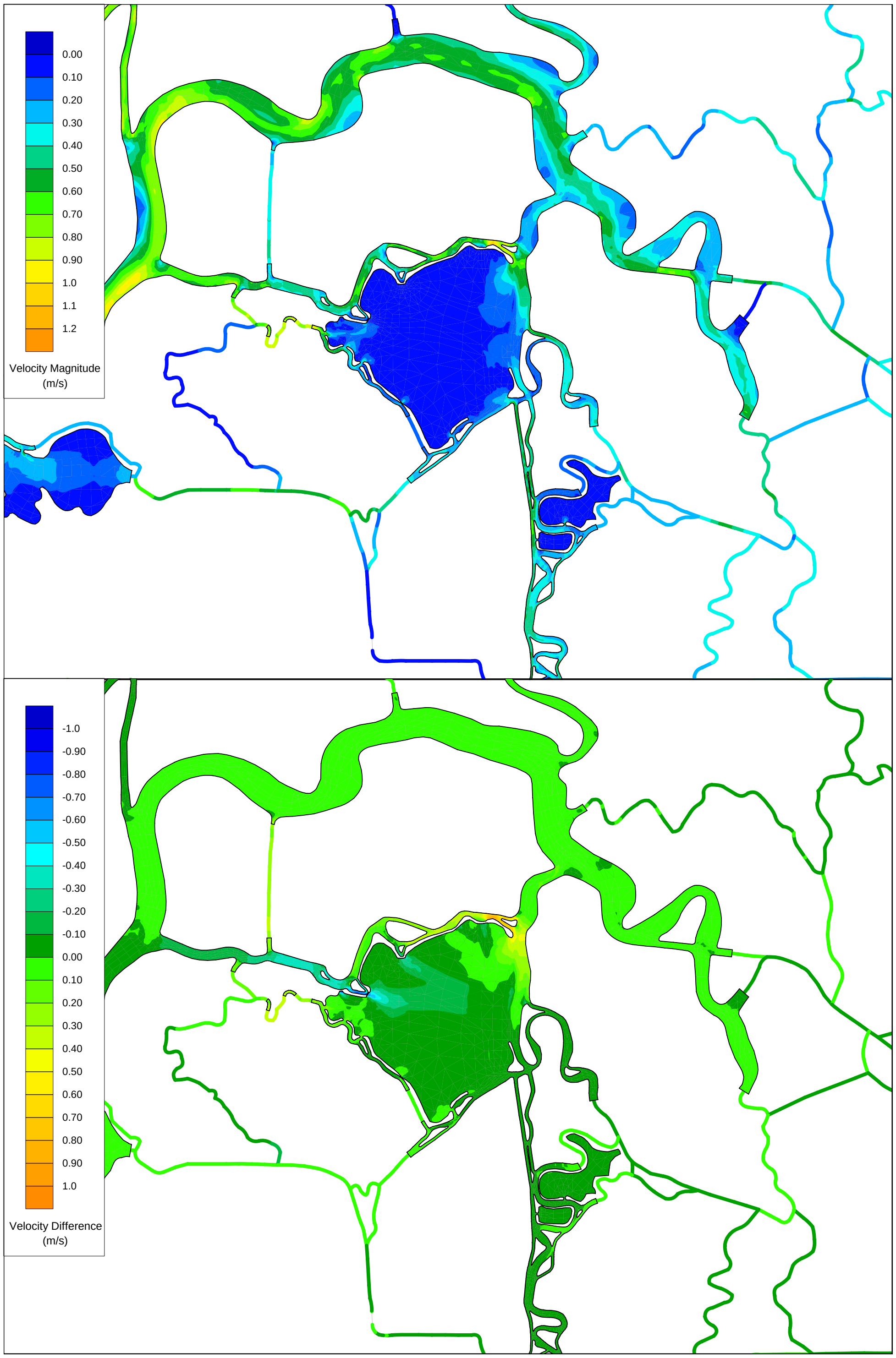

Figure 7-11 "North Levee and Close Little Franks Tract" alternative: peak velocity magnitude and change in peak velocity from Base case during July 10 12:00 through July 12 12:00.

8 CONCLUSIONS

Simulation results show potentially significant improvement in water quality in the Delta with implementation of Franks Tract management alternatives. The alternative producing the most significant EC reductions overall, the “East Levee and Gates” alternative, reduces EC by as much as 19% at SWP, 15% at CVP, 27% at the Contra Costa Old River intake, 31% at the Contra Costa Rock Slough intake and 16% at Jersey Point. These results stem from reduction of salinity in Old River south of Franks Tract. In Middle River at RMID023, EC is increased by as much as 8%. Most alternatives resulted in an increase at this location.

There is a tradeoff between water quality in the south Delta and residence time in Franks Tract. The alternative that produced the lowest EC values at the export locations, the “East Levee and Gates” alternative, also produced the longest residence times in Franks Tract (15 days). Other alternatives resulting in significant reductions at the intakes, “East Side Open”, “Cox Alternative” and “West False River Gate 1/3 Flow”, also increased residence time in Franks Tract to 7 to 12 days. Base case residence time is approximately 4 days.

The “No Franks Tract” alternative is the only alternative that results in reduced EC values at RMID023 throughout most of the simulation period. At Jersey Point, the most significant EC reductions are achieved with the “West False River Gate” alternative, the “False River and Piper Slough Gates” alternative, and the “North Levee, Nozzle Gate and Piper Slough Gate” alternative.

Residence times are not significantly changed for the “West False River Gate”, “False River and Piper Slough Gates”, and “North Levee and Nozzle Gate” alternatives. For the “North Levee, Nozzle Gate and Piper Slough Gate” alternative, the maximum residence time on September 1 is about 1 day less than the Base case.

The difference in water quality between the “West False River Gate” full flow and 1/3 flow alternatives suggests that gate optimization can make a significant difference and should be pursued for any of the alternatives that are considered for implementation.

Gate operations may need to be modified for the "East Levee and Gates" alternative to improve residence time in Franks Tract.

Impacts to minimum and maximum stage during July were minimal for the "West False River Gate" alternative. Minimum stage was lowered by no more than 0.01 m. Changes in maximum stage ranged from -0.05 m to +0.02 m. For the "Cox Alternative" minimum stage was lowered by no more than 0.02 m. Changes in maximum stage ranged from -0.12 m to +0.02 m.

There were no significant stage increases for the "East Levee and Gates", "North Levee and Nozzle Gate" or "East Side Open" alternatives during the flood or extreme high tide events.

Velocity results suggest that several of the alternatives may have potential for scour problems. For the "No Franks Tract", "False River and Piper Slough Gates", "North Levee and Nozzle Gate", "North Levee and Close Little Franks Tract" and "East Levee and Gates" alternatives, velocities are increased in False River adjacent to Webb Tract where the channel side is steep. The "North Levee and Close Little Franks Tract" also increases velocities at Horseshoe Bend on Piper Slough along Bethel Island where channel sides are steep.